Let's protect our earth

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL QUALITY
Bureau of Technical Services
CN 411
Trenton, N.J. 08625-0411
(609) 530-4041

October 16, 1991

MEMORANDUM

TO: Chief
Bureau of Enforcement Operations

FROM: Edward Choromanski, Chief
Bureau of Technical Services

SUBJECT: Camden County Energy Recovery Associates
Camden, New Jersey
Stack Emission Test Program - Monthly Lead Tests
APC Plant ID No. 50617
NJ Stack No. 001
P/CT No. 83668 (Log No. 87-1012)

Stack emission tests were conducted at the above referenced facility on August 27, 1991 on Unit No. 1. The purpose of these tests was to quantify the emissions of lead from Unit No. 1 to the atmosphere.

Richelle Burkeen reviewed the final test report. Her review indicates that the test report submittal contained the emission test results for only two test runs. The results of the third test were not provided due to a quality control problem attributed to improper labeling of the inlet or outlet filter samples between the testing contractor (Entropy) and the sub-contracted laboratory.

The results of the outlet lead tests indicate that they were below the detectable limit. Based on the detection limit of lead, the source would have been within the permit allowable emission standard. The source was below the detection limit therefore, the outlet lead emission rate reported by Ms. Burkeen are conservative.

Although only the results of two test runs for lead were reported, I recommend that we accept these results. There will be at least 10 more monthly lead test programs which will be conducted to insure compliance with the permit standard.

c William O'Sullivan
Don Patterson
Iclal Atay
Chuck DeWeese
Scott Hawthorne
Richelle Burkeen

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
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CN 411
Trenton, N.J. 08625-0411
(609) 530-4041

October 12, 1991

MEMORANDUM

TO: Edward Choromanski

FROM: Richelle Burkeen RSB

SUBJECT: Camden County Energy Recovery Associates
Monthly Lead Tests
Camden, New Jersey
APC Plant ID No. 50617
NJ Stack No. 001
P/CT No. 083668

On August 27, 1991, monthly lead tests were conducted at the above referenced facility. Sampling was performed at the inlet and outlet of Unit No. 1. Three concurrent sets of metal runs were conducted to determine lead emissions and removal efficiencies.

It should be noted that an inconsistency existed between the testing company's on site sample recovery description (which described the filter clean) and the laboratory's analytical documentation (which described the filter dirty) for the outlet filter for run three. It is believed by the facility and the testing company that the inlet filter was analyzed as the outlet filter, resulting in suspect outlet emissions. Because of this, Entropy Environmentalists Inc. did not report outlet emissions for run three. The results that were reported are as follows.

EMISSIONS

	Run 1	Run 2	Run 3	Allowable
INLET				
Lead				
ug/DSCM	17,907	25,139	21,579	
lb/hr	3.05	4.24	4.03	
OUTLET				
Lead				
ug/DSCM	<8.70	<8.52	-	
lb/hr $x10^{-3}$	<1.55	<1.55	-	80
DRE %	99.95	99.96		

OPERATING DATA

	Run 1	Run 2	Run 3
Avg. Furnace Temp. (°F)	1169	1173	1184
Economizer Outlet Gas Temp. (°F)	464	467	473
Feedwater Flow (lb/hr)	90,368	89,856	91,162
Feedwater Pressure (psig)	1093	1093	1183
Lime Slurry Flow (gpm)	10.7	10.2	8.8
Lime Slurry pH (pH)	7.0	7.0	7.0
Oxygen (%)	8.0	8.4	8.4
Opacity (%)	0.07	0.24	0.21

In addition to the above process data, 325.5 tons of waste was charged for the day of the tests.

Technical Services review of the raw data supplied indicates substantially the same results. The results indicate that the two outlet emissions that were reported are below the permit allowable of 0.08 lb/hr. In addition to the emissions, the removal efficiency of Unit No. 1 was approximately 99.96%.

Although the reported emissions were within the permit allowable, it is noted that permit condition 8(b) was not met. This requirement specifies that a minimum of three successive 1-hour test runs should be conducted monthly.

CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES

PERRYVILLE CORPORATE PARK • CLINTON, NEW JERSEY 08809-4000 • PHONE 201-730-4000

GENERAL PARTNERS
CAMDEN COUNTY ENERGY RECOVERY CORP.
FOSTER WHEELER CAMDEN COUNTY, INC.

CAMDEN RESOURCE RECOVERY FACILITY

I certify under penalty of law that the information provided in this document is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including fines or imprisonment or both, for submitting false, inaccurate or incomplete information.

B. C. Studley

Bruce C. Studley, P.E.
Vice President, Plant Operations
Foster Wheeler Power Systems, Inc.

October 2, 1991
(Date)

REPORT CERTIFICATION

SUBMITTAL DATE
October 2, 1991

The project was carried out under my direction and supervision. To the best of my knowledge, the data presented in this report is accurate and complete.

Signature Allan F. Lowe

Allan F. Lowe
Project Manager

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LIST OF TABLES AND FIGURES

INTRODUCTION

1.1 Outline of Test Program. This report covers stationary source sampling performed on August 27, 1991 at the Unit No. 1 SDA inlet and stack. Three sets of concurrent EPA MMTL runs were conducted to determine the lead emissions and removal efficiencies.

TABLE 1-1

UNIT NO. 1 TEST LOG

Sampling Location	Emissions Measured	Sampling Method	Run Numbers - Repetition 1	2	3
SDA Inlet	Carbon Dioxide and Oxygen	EPA 3	1-I-M3-1	1-I-M3-2	1-I-M3-3
	Lead	EPA MMTL	1-I-MMTL-1	1-I-MMTL-2	1-I-MMTL-3
Stack	Carbon Dioxide and Oxygen	EPA 3	1-S-M3-1	1-S-M3-2	1-S-M3-3
	Lead	EPA MMTL	1-S-MMTL-1	1-S-MMTL-2	1-S-MMTL-3

1.2 Test Participants. Table 1-2 lists the personnel involved in the test program.

TABLE 1-2

TEST PARTICIPANTS

Camden County Resource Recovery Facility	Steve Warlick, Test Coordinator
New Jersey State Department of Environmental Protection	Richelle Burkeen, Test Observer
Entropy Environmentalists Inc.	Leslie C. Murray, Project Manager
	W. Todd Langdon, Sampling Team Leader
	William E. Morgan, Sampling Team Leader
	Eric C. Swope, Engineering Technician
	Lauren A. Sherwood, Laboratory Technician

SUMMARY OF RESULTS

2.1 Presentation. Table 2-1 presents the lead emission rates, concentrations, and removal efficiencies. Tables 2-2 and 2-3 are run-by-run tests summaries for the testing conducted at the SDA inlet and stack, respectively. Detailed test results are presented in Appendix A; field data is given in Appendix B; and analytical data is provided in Appendix C.

2.2 Lead Results, Run 1-S-MMTL-3. The analytical result for run 1-S-MMTL-3 is significantly greater than those for runs 1-S-MMTL-1 and 1-S-MMTL-2. An inconsistency exists between Entropy's onsite sample recovery and sample appearance documentation (which describes the stack filter as clean) and the subcontracted laboratory's analytical documentation (which describes the stack filter as dirty). Because more than one filter was used for each inlet run, it is possible that an inlet filter was analyzed instead of the stack filter. Due to these factors, the analytical results for run 1-S-MMTL-3 are highly suspect. No emission rate or concentration for the run appear in this report and a two-run average is presented.

TABLE 2-1

EMISSION RATES, CONCENTRATIONS, AND REMOVAL EFFICIENCIES

Unit No. 3

	Repetition 1	Repetition 2	Repetition 3	Average
Emission Rate, lb/hr				
SDA Inlet	3.05	4.24	4.03	3.77
Stack	< 0.00155	< 0.00155	- -	< 0.00155
Concentration, µg/DSCM				
SDA Inlet	17,907	25,139	21,579	21,542
Stack	< 8.70	< 8.52	- -	< 8.61
Removal Efficiency, % *	> 99.95	> 99.96	- -	> 99.96

* Removal Efficiency = $100 \times \dfrac{[\text{lb/hr}]_{\text{SDA Inlet}} - [\text{lb/hr}]_{\text{Stack}}}{[\text{lb/hr}]_{\text{SDA Inlet}}}$

TABLE 2-2

LEAD TESTS SUMMARY

Unit No. 1 Spray Dryer Absorber Inlet

	1-I-MMTL-1	1-I-MMTL-2	1-I-MMTL-3	Average
Run Date	8/27/91	8/27/91	8/27/91	
Run Start Time	0830	1150	1620	
Run Finish Time	1059	1454	1954	
Test Train Parameters:				
Volume Of Dry Gas Sample, SCF *	71.776	65.597	76.908	
Percent Isokinetic:	100.4	99.0	98.8	
Flue Gas Parameters:				
CO_2, Percent By Volume, Dry	9.5	8.5	8.7	8.9
O_2, Percent By Volume, Dry	9.7	10.6	10.3	10.2
Temperature, °F	420	423	429	424
Air Flow Rate, Dry SCFM *	45,515	45,055	49,885	46,818
Air Flow Rate, Wet ACFM	91,017	89,219	99,789	93,342
Excess Air, Percent	83	99	93	92
Lead:				
Concentration, ug/DSCM *	17,907	25,139	21,579	21,542
Emission Rate, lb/hr	3.05	4.24	4.03	3.77

* 68° F (20° C) -- 29.92 Inches of Mercury (Hg)

TABLE 2-3

LEAD TESTS SUMMARY

Unit No. 1 Stack

	1-S-MMTL-1	1-S-MMTL-2	Average
Run Date	8/27/91	8/27/91	
Run Start Time	0830	1150	
Run Finish Time	1058	1451	
Test Train Parameters:			
Volume Of Dry Gas Sample, SCF *	81.163	82.863	
Percent Isokinetic:	100.9	101.0	
Flue Gas Parameters:			
CO_2, Percent By Volume, Dry	8.5	8.4	8.5
O_2, Percent By Volume, Dry	10.9	10.5	10.7
Temperature, °F	260	261	261
Air Flow Rate, Dry SCFM *	47,683	48,622	48,153
Air Flow Rate, Wet ACFM	80,336	81,798	81,067
Excess Air, Percent	105	96	101
Lead:			
Concentration, ug/DSCM *	< 8.70	< 8.52	< 8.61
Emission Rate, lb/hr	< 0.00155	< 0.00155	< 0.00155

* 68° F (20° C) -- 29.92 Inches of Mercury (Hg)

< Indicates the value is below the detection limit.

PROCESS DESCRIPTION AND OPERATION

3.1 General. The Camden County Resource Recovery Facility in Camden, New Jersey operates three mass-fired municipal refuse burning furnaces which produce electricity for sale to a local utility company. Each of the mass-fired boilers is equipped with a spray dryer absorber (SDA) for acid gas removal. The SDA is followed by an electrostatic precipitator (ESP) for the control of suspended particulate emissions. Each ESP is followed by an induced draft fan which directs the flue gas to a reinforced concrete stack. The facility has continuous emissions monitors for CO, SO_2, and O_2 at the SDA inlet and for SO_2, NO_x, O_2, and opacity in the stacks. A microprocessor-based data acquisition system receives data from the monitoring system and is equipped with a printer which provides hard copies of emission values.

Bottom ash from the combustion grates and collected flyash are collected in a "semi-dry" conveying system. Sufficient moisture is added to the combined ash or "residue" to suppress dusting. A vibrating conveyor discharges residue from each boiler to an enclosed common ash storage area. A clam shell loader transfers the material to a vibrating conveyor and trommel screen separator. Oversize material is reclaimed as ferrous residue. Material passing through the screen is landfilled by truck.

3.2 Source Air Flow. Figure 3-1 is an air flow schematic which shows the passage of flue gases exhausted from the boiler.

3.3 Operation During Testing. Detailed process data supplied by Camden County Resource Recovery Facility is presented in Appendix E.

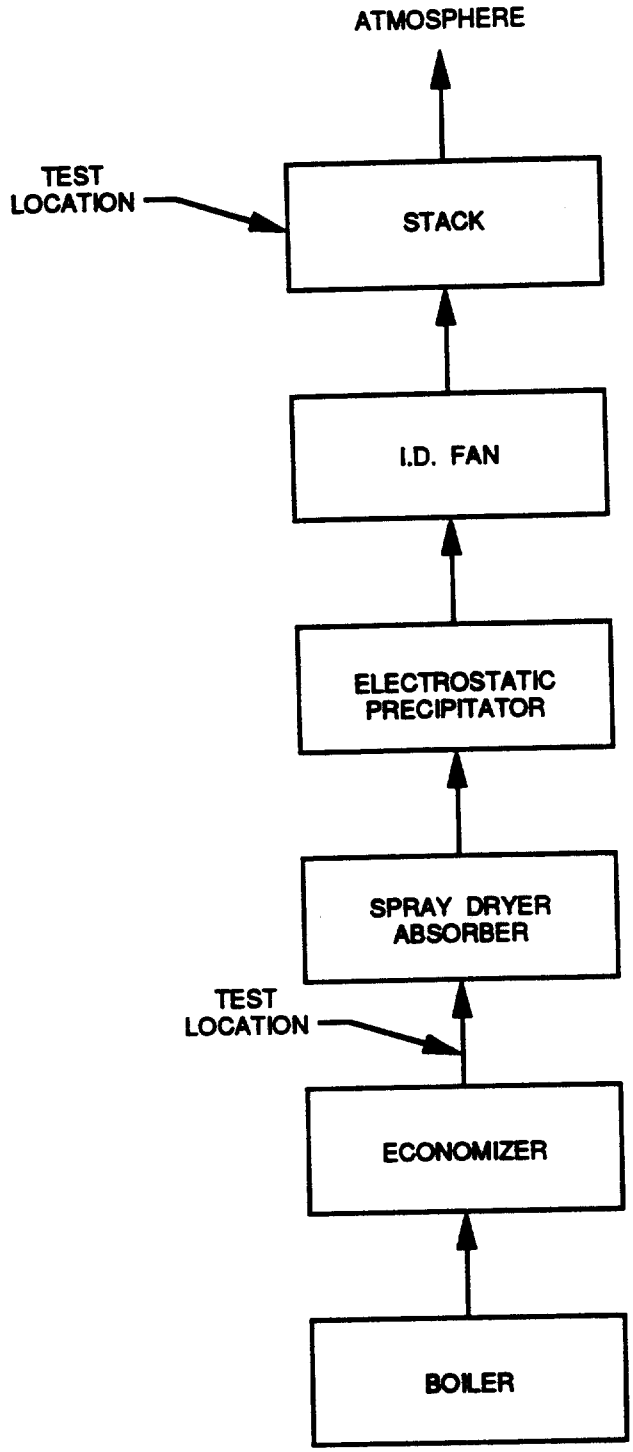


FIGURE 3-1. UNIT NOS. 1, 2, AND 3 AIR FLOW SCHEMATIC.

SAMPLING AND ANALYTICAL PROCEDURES

4.1 General. All sampling and analytical procedures were those recommended by the United States Environmental Protection Agency and the New Jersey State Department of Environmental Protection. This section provides brief descriptions of the sampling and analytical procedures. Detailed descriptions of the procedures are provided in Appendix F.

4.2 Sampling Points. The number and location of the sampling points were determined according to the procedures outlined in EPA Method 1. The SDA inlet duct cross section was divided into 24 equal areas with 12 sampling points on each of two axes, as shown in Figure 4-1. The stack cross section was divided into 12 equal areas with six sampling points on each of two axes, as shown in Figure 4-2.

4.3 Volumetric Air Flow Rates

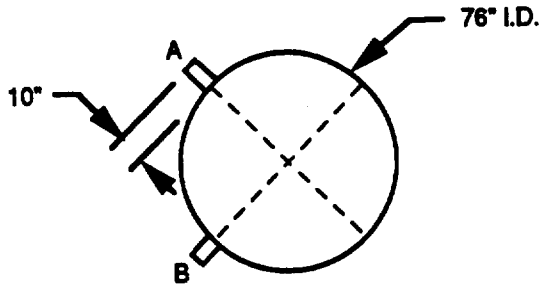
4.3.1 Flue Gas Velocity. The flue gas velocity and volumetric flow rate were determined according to the procedures outlined in EPA Method 2. Velocity head measurements (delta P) were made using Type S Pitot tubes conforming to the geometric specifications outlined in EPA Method 2. Accordingly, each has been assigned a coefficient of 0.84. Differential pressures were measured with Magnehelic gauges of appropriate range. Flue gas temperatures were measured with chromel-alumel thermocouples equipped with hand-held digital readouts.

4.3.2 Flue Gas Composition. Flue gas samples were collected using the multipoint, integrated sampling technique outlined in EPA Method 3.

Sample Collection. A stainless steel probe and a peristaltic pump delivering 500 to 750 mL/min of flue gas were used to fill a Tedlar bag. Moisture was removed by means of a knockout jar located prior to the pump. Sampling was of the same duration (except purges following port changes) as the pollutant emissions runs.

Sample Analysis. Analysis for carbon dioxide and oxygen was performed using an Orsat apparatus. The analytical results were used to determine the flue gas composition, molecular weight, and excess air.

(continued on page 4-4)



TRAVERSE POINTS

2 AXES
12 POINTS / AXIS
24 TOTAL POINTS

SECTION K-K

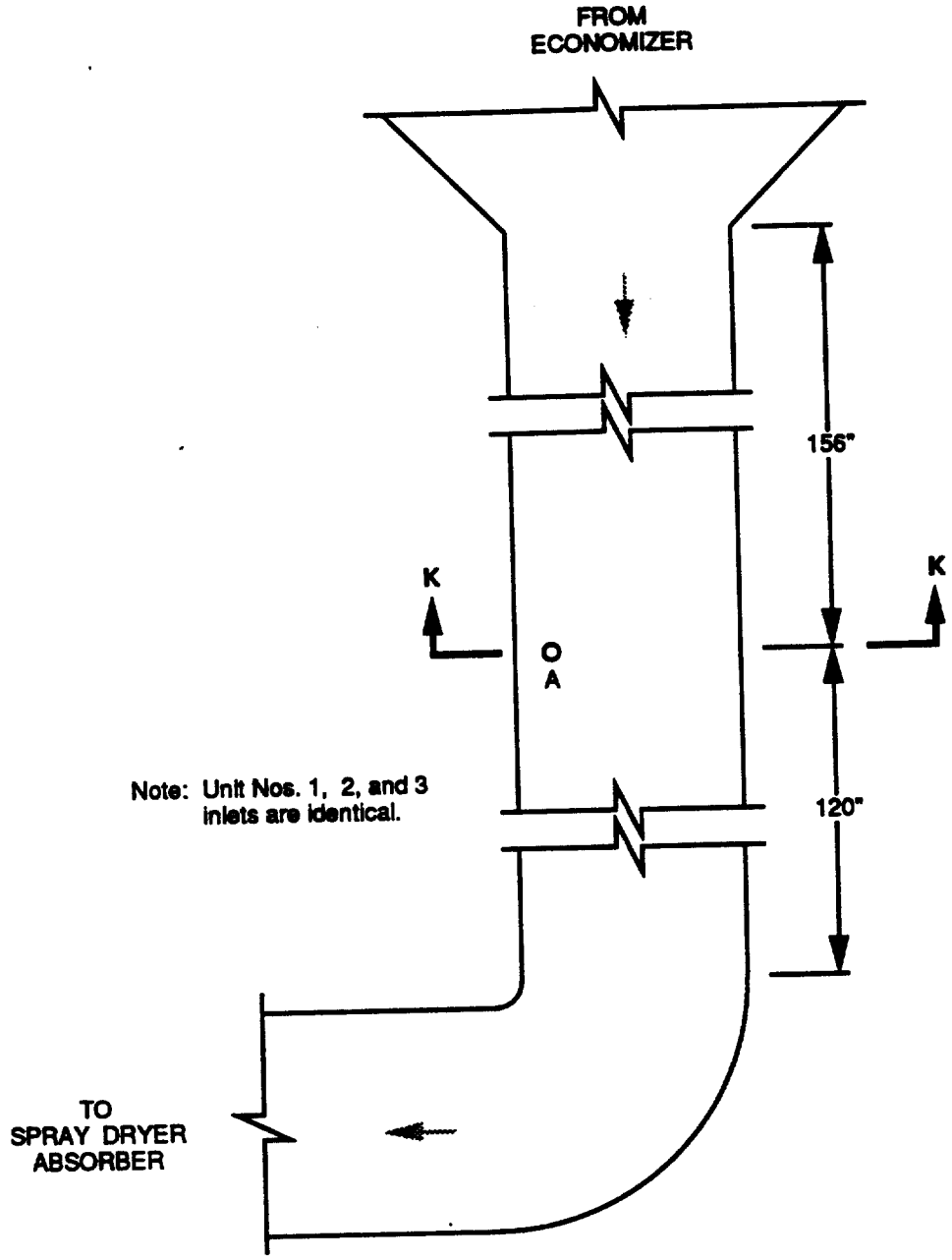
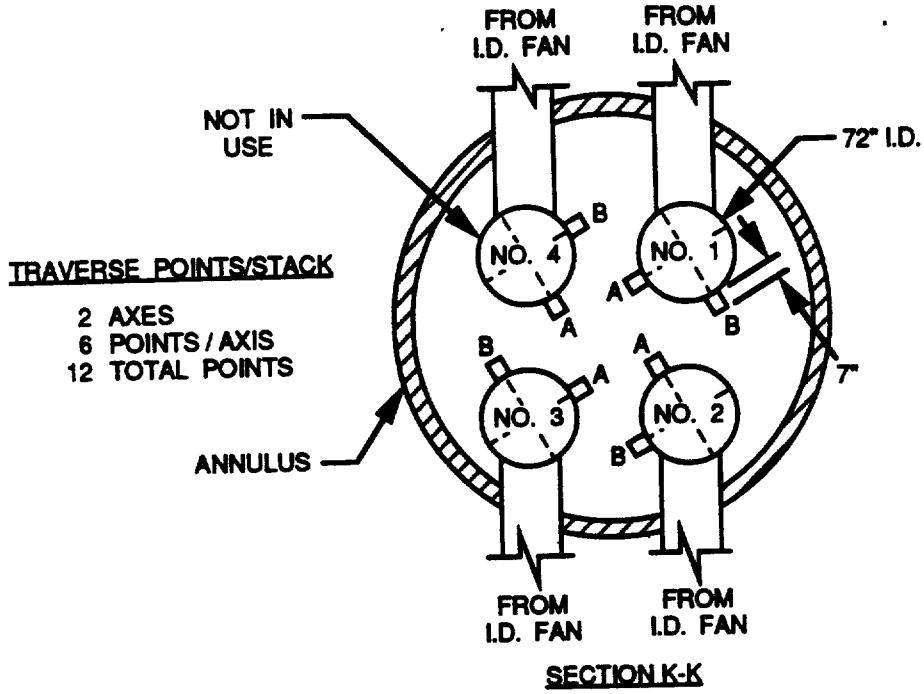
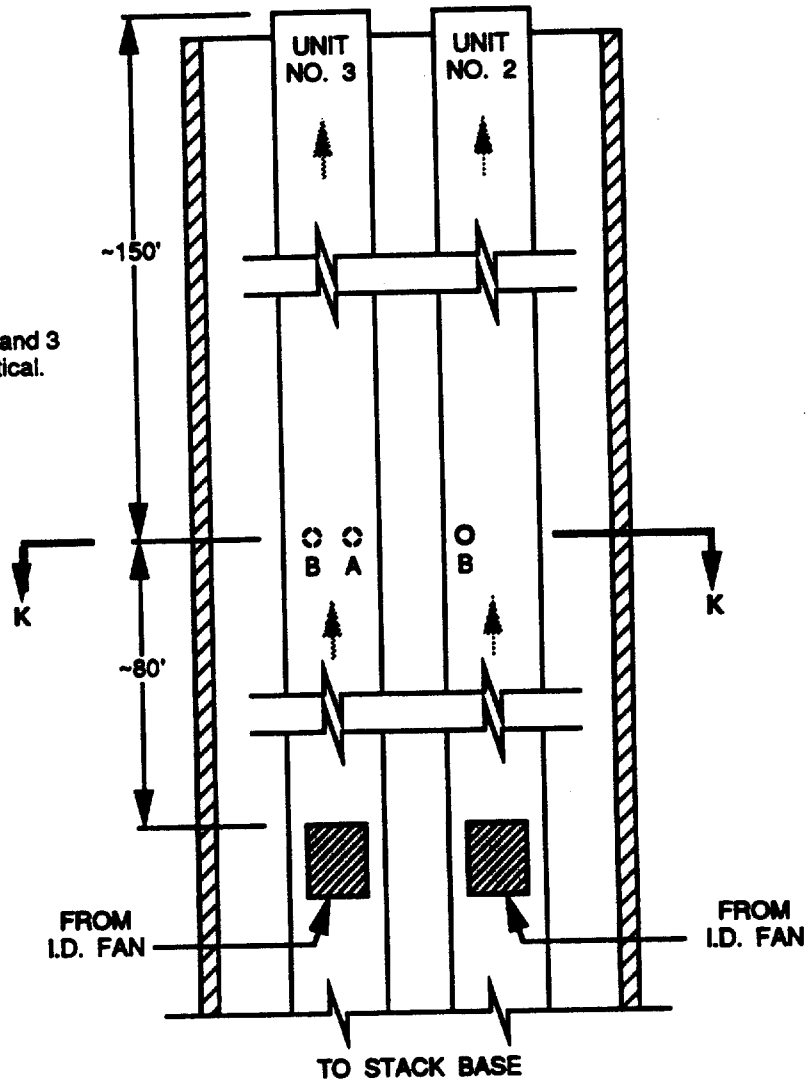


FIGURE 4-1. UNIT NOS. 1, 2, AND 3 SDA INLETS TEST LOCATION.





Note: Unit Nos. 1, 2, and 3 stacks are identical.

FIGURE 4-2. UNIT NOS. 1, 2, AND 3 STACKS TEST LOCATIONS.

4.3.3 Flue Gas Moisture Content. The moisture content was determined in conjunction with the lead emissions testing discussed in the following section.

4.4 Emissions Determinations. Samples were withdrawn isokinetically from the source using an EPA Draft Multi-Metal sampling train.

Sample Collection. The sampling train consisted of a glass nozzle, a heated glass probe with a Type S Pitot tube attached, a filter, four chilled impingers, and a metering console. The particulate sample was collected on a Pallflex 2500QAT-UP quartz filter maintained at a temperature of 248°F ± 25°F. The first impinger was empty, the second and third impingers each contained 100 mL of 5% nitric acid (HNO_3)/10% hydrogen peroxide (H_2O_2), and the fourth contained preweighed silica gel. Each run was a minimum of two hours in duration with a minimum sample volume of 60 dry standard cubic feet. At the SDA inlet, each of the 24 points was sampled for five minutes, resulting in net run times of 120 minutes. At the stack, each of the 12 points was sampled for ten minutes, resulting in net run times of 120 minutes.

Sample Recovery. A Teflon spatula and Teflon coated tweezers were used to remove the filter from the filter holder and place it in a 250 mL glass jar. The reagents were returned to the original bottles, weighed, the weights recorded on the labels, and the liquid levels marked. The silica gel was returned to the original container, weighed, and the weight recorded on the label. The volume of water vapor condensed in the impingers and the volume of water vapor collected in the silica gel were summed and entered into moisture content calculations.

The nozzle, probe, and fronthalf of the filter holder were rinsed with 100 mL of 0.1N HNO_3 into a cleanup jar followed by rinsing with distilled, deionized (DI) water into a second jar. A Teflon probe brush was used for cleaning the probe.

The backhalf of the filter holder and the first, second, and third impingers were rinsed with 100 mL of 0.1N HNO_3 into the separate jar.

Sample Analyses. The fronthalf HNO_3 rinse was evaporated to near dryness in a Teflon beaker. The filter, loose particulate, 3 mL of concentrated HNO_3, and 5 mL of concentrated HF were added to the beaker. The sample was digested on a hotplate until brown fumes were evident, indicating the destruction of organic matter. After the addition of concentrated HNO_3, the reagent and impinger rinses were evaporated to near dryness in a Teflon beaker on a hotplate. After cooling,

3 mL of concentrated HNO_3 and 5 mL of concentrated HF were added to the beaker and the sample was fumed on a hotplate to destroy organic residue. The prepared filter and HNO_3/H_2O_2 reagent samples were combined, brought to a final volume of 100 mL with 10% HNO_3, and analyzed for lead with a Perkin Elmer 3030 atomic absorption analyzer using SW-846 Method 7420. Duplicate metals analyses were performed for approximately 33% of the emissions samples.

4.5 Equipment Calibration. Pertinent calibration data are provided in Appendix D.

QUALITY ASSURANCE/QUALITY CONTROL

5.1 General. Entropy Environmentalists Inc. (EEI) is committed to the continued implementation of a Quality Assurance Program to assure the quality of sampling and analytical procedures of environmental measurement data. The Quality Assurance measures taken during this test project equals or exceeds the minimum QA/QC recommendations as set forth by the U.S. Environmental Protection Agency (EPA) for a particular method.

The following sections outline the QA program implemented by EEI to justify the validity of test procedures. As applicable, the QA system for the various test programs addresses the following areas:

- Preventive Maintenance & Equipment Calibration
- QA Sample Processing
- Analytical Instrument Calibration
- Blanks and Spiked Samples
- Internal/External System Checks
- Data Reduction & Validation
- QA/QC Summary

5.2 Preventive Maintenance and Equipment Calibration. An effective preventive maintenance program decreases downtime and thus increases data completeness and quality. Pretest and posttest equipment calibrations are conducted in a manner and at a frequency which meets or exceeds U.S. EPA specifications.

Each item transported to the field is inspected to detect equipment problems which may originate during periods of storage. All equipment returning from the field is cleaned, repaired, reconditioned, and recalibrated as necessary. Routine maintenance on equipment (dry gas meters, pumps, Magnehelics, manometers, pitot tubes, and nozzles) is carried out periodically for leaks, corrosion, dents, or any other damage. Table 5-1 shows the activities for equipment calibration.

TABLE 5-1

IN-HOUSE EQUIPMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Type S Pitot Tubes	Standards contained in EPA Method 2. Visual inspection prior to shipment to test site and again prior to each day of testing.	Coefficient of 0.84 ± 0.02	Refurbish or recalibrate.

(continued next page)

TABLE 5-1 (continued)

IN-HOUSE EQUIPMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Manometers	Leak checked before and after each field use.		Adjust or replace.
Magnehelic Gauges	Initially calibrated over full range.	0-10" water column	
	After each field use, checked against inclined manometer at average settings encountered during testing.	Within ± 5%	Repair and Recalibrate.
Thermometers -Impinger -Dry Gas Meter -Filter Box	After purchase and prior to each field use, using ASTM mercury-in-glass thermometer.	Imp = ± 2°F DGM = ± 5.4°F FB = ± 5.4°F	Adjust, determine correction factor, or reject.
Thermocouple/ Potentiometer	After purchase. 3-point (ice bath, boiling water, and hot oil) using ASTM mercury-in-glass thermometer.	± 1.5% of absolute temperature.	Adjust, determine correction factor, or reject.
	Before and after each field use, compared to ASTM mercury-in-glass thermometer at ambient conditions.		
Dry Gas Meter and Orifice	Full calibration (every 6 months) over wide range of orifice settings to obtain calibration factor (isokinetic meterbox).	DGM = ± 0.02 from avg.coeff. for each run. Ori. = ± 0.15" H20 over delta H range of 0.4" to 4.0"	Adjust or replace.
	10-minute quick calibration before sending to test site and again prior to each day of field use (isokinetic).	± 3% of full. ± 5% of full.	Use if no backup. Do not use.
	Posttest (at average delta H and highest vacuum encoun-) tered during testing) to determine if meter gamma has changed (isokinetic).	± 5% of full calibration. Gamma (initial or recalibration) that yields the lowest sample volume for the testing is used for calculations.	Recalibrate or replace.
	Full calibration w/spirometer before/after each field use (nonisokinetic meterbox).	± 5% of pretest, .02 from average coeff. from each run	Recalibrate.
Dry Gas Meter Transfer Standard	Annual calibrations conducted in triplicate using EPA wet test meter. Calibrations conducted at 7 flow rates from 0.25 to 1.40 cfm.	± 2% of average factor for each calibration run.	Adjust and recalibrate.
Barometer	Before and after each field use against an aneroid barometer.	± 0.1" mercury.	Adjust to agree.
	Reference barometer adjusted for elevation differences.		
Probe Nozzle	Average of 5 I.D. measurements using a micrometer. Visual inspection before and after each field use.	Difference between high and low measurement ≤ 0.004"	Repair and recalibrate.

5.3 Sample Processing. Entropy employs systems which ensure the integrity of an environmental sample from the time of acquisition, through analysis, and ultimately to proper disposal. These systems are necessary to allow valid

conclusions to be drawn from analytical results separated in time and space fromthe sampling operation. In addition, these systems recognize that samples are occasionally of value even after analytical results have been reported.

Samples are collected, transported, and stored in clean containers which are constructed of materials inert to the analytical matrix. Containers are used which allow air tight seals. When necessary, containers are employed which prevent photochemical reactions. All sample containers are labeled with the following information:

- Unique source identifier
- Sample run identifier
- Analyte identifier
- Sample matrix identifier
- Sample analyst identifier

Additional information relating to the sample is recorded on the data sheet for the sampling run that afforded the subject sample. Accordingly, the sampling data sheet contains all the information listed above, plus the date and time the sample was acquired and supplemental information such as observations pertinent to the quality of the sample. For condensed samples, e.g., samples in liquid media, the sample levels are marked on the outside of the container; this mark is used to indicate sample loss, and as such, may serve as a reference in adjusting results accordingly.

For transport from the field to the laboratory, samples are stored in sealed containers and secured in a fashion which minimizes movement and thus prevents breakage of containers. Containers used for transporting glass are packed with foam. Samples which reqiuire chilling are kept cold until analyzed

Samples remain in the custody of the sampler, from acquisition until conveyance to the sample custodian. All custody transfers are signed for and documented on a record of custody form, which remains with the sample until turned over to the custodian.

Analytical data are identified in a manner identical to that of the sampling data. Accordingly, all data generated from the analysis of samples are documented with the following information:

- Source identifier
- Sample run identifier
- Analyte identifier
- Sample matrix identifier
- Analyst identifier
- Analysis date

Portions of samples remaining after analysis are returned to their original

sample containers. These samples are stored in designated storage areas until their destruction is authorized.

5.4 Instrument Calibration. Instrument calibration is one of the most important functions in generating precise and accurate quality data. A listing of major in-house instrumentation and the corresponding Quality Assurance program is given in Table 5-2.

All of the contract laboratories involved in the analytical testing for the test program maintained rigorous QA programs for instrument calibration.

TABLE 5-2

IN-HOUSE INSTRUMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Corrective Specifications	Action
Analytical & Top Loading Balance	Daily and monthly checks with a series of class S weights.	± 1 mg of class S weights.	Adjust or repair.
	Balance serviced annually by a qualified service representative and checked with a series of NBS weights.		
Gas Chromatograph	3-point calibration curve at the expected range.		
	Duplicate injection of the sample until ± 5% variation is achieved.		
	Calibration repeated at the end of each test series.		
HPLC/Ion Chromatograph	Calibrations conducted at the beginning, after the first injection, and after the second injection.		
Fisher Accument 925 pH/Selective Ion Meter	5- point calibration prior to analyzing the samples for the specific ions.		

5.5 Blanks and Spikes. Field blanks, method blanks, trip blanks, lab-proof blanks and filter blanks are obtained, digested and analyzed when applicable. The blanks reflect the background contamination obtained from the various sources during the sampling and analysis. Thus, data adjustment or correction can be made accordingly.

In most cases, it is not necessary to digest and analyze the method blanks, reagent blanks or the lab-proof blanks unless the field blank shows a high level of contamination. If a high level of contamination is present, it is imperative to individually analyze the above blanks to help determine the cause of contamination.

Spiked samples are used to check on the performance of a routine analysis or the recovery efficiency of a method. During spiking, a known amount of stock solutions of the substance of interest is added to the sample prior to sample extraction, digestion, and analysis.

5.6 Internal/External System Audit Checks. System and performance audits are routine elements of all Entropy QA/QC programs.

Internal Systems Audit: The following sampling equipment checks were conducted prior to sample collection.

- All sampling equipment was thoroughly checked to ensure clean and operable components.
- Equipment was inspected for possible damage from shipment.
- The oil manometers or Magnehelic gauges were leveled and zeroed.
- The temperature measurement systems were checked for damage and operability by measuring the ambient temperature.

Performance Audits: Performance audits of the laboratory are conducted prior to the processing of any compliance samples for analysis. Audit materials typically include samples available from the EPA prior to new source testing. Also, samples of known concentration are specially prepared in-house or obtained from the EPA for Internal QA checks.

External Sytems Audits: Entropy is subject to a system audit each time a test is conducted for any Air Pollution Control agency. This procedure entails an EPA observer on-site to do qualitative evaluation of performance to demonstrate compliance with the applicable regulations.

5.7 Data Reduction and Validation. The test team leader is responsible for reviewing and validating data as they are acquired. Each team leader has extensive knowledge of sampling methodology and the characteristics of the process being measured and is capable of evaluating the accuracy, representativeness, and completeness of raw data on-site, where action to replace inadequate data can be taken immediately.

Data obtained during calibrations and test runs are recorded on standardized forms which are checked twice for completeness and accuracy by the QA Director or his designated representative. Data reduction and consistency are achieved by using the standardized forms and using Entropy's in-house computer facilities.

AVERAGE FLUE GAS VELOCITY [Note: (Delta p)avg is square of average square root]

$$vs = 85.49 * Cp * \left[\frac{(Delta\ P)avg * (460 + ts)}{Ps * Ms} \right]^{\frac{1}{2}}$$

$$vs = 85.49 * 0.840 * \left[\frac{0.4270 * (460 + 420)}{29.94 * 27.92} \right]^{\frac{1}{2}} = 48.15 \text{ ft/sec}$$

DRY VOLUMETRIC FLUE GAS FLOW RATE AT STANDARD CONDITIONS

$$Qsd = \frac{60}{144} * Mfd * vs * A * \frac{460 + tstd}{460 + ts} * \frac{Ps}{Pstd}$$

$$Qsd = \frac{60}{144} * 0.833 * 48.15 * 4,536.5 * \frac{460 + 68}{460 + 420} * \frac{29.94}{29.92}$$

Qsd = 45,515 DSCFM

WET VOLUMETRIC FLUE GAS FLOW RATE AT ACTUAL CONDITIONS

Qaw = 60 / 144 * vs * A

Qaw = 60 / 144 * 48.15 * 4,536.5 = 91,017 ACFM

PERCENT ISOKINETIC OF SAMPLING RATE

$$\%I = \frac{Pstd}{460 + tstd} * \frac{100}{60} * \frac{(ts + 460) * Vmstd}{Ps * vs * Mfd * Theta * (\pi * (NozzleDia/2)^2/144)}$$

$$\%I = \frac{29.92}{460 + 68} * \frac{100}{60} * \frac{(420 + 460) * 71.776}{29.94 * 48.15 * 0.833 * 120.00 * (\pi * (0.275/2)^2/144)}$$

%I = 100.4 %

PERCENT EXCESS AIR

$$\%EA = \frac{\%O_2 - (0.5 * \%CO)}{0.264 * (100 - \%CO_2 - \%O_2) - (\%O_2 - (0.5 * \%CO))} * 100$$

$$\%EA = \frac{9.7 - (0.5 * 0.0)}{0.264 * (100 - 9.5 - 9.7) - (9.7 - (0.5 * 0.0))} * 100 = 83 \%$$

CONCENTRATION, MICROGRAMS PER DRY STANDARD CUBIC METER, LEAD

$$ug/DSCM = \frac{(ug / 10^6)}{Vmstd * 0.02832} * 10^6$$

$$ug/DSCM = \frac{(36400.0/10^6)}{71.776 * 0.02832} * 10^6 = 17,907 \text{ ug/DSCM}$$

EMISSION RATE, POUNDS PER HOUR, LEAD

$$lb/hr = \frac{60}{453.592} * \frac{(ug / 10^6)}{Vmstd} * Qsd$$

$$lb/hr = \frac{60}{453.592} * \frac{(36400.0/10^6)}{71.776} * 45,515 = 3.05 \text{ lb/hr}$$

APPENDIX B.1

B. FIELD DATA

1. Spray Dryer Absorber Inlet

Sampling and Velocity Traverse Point Determination
EPA Method 1

CAMDEN COUNTY RRF

PLANT NAME ~~Ensco Wheeler~~

CITY, STATE CAMDEN, NJ

SAMPLING LOCATION #1, 2, 3 DA INLETS

NO. OF PORTS AVAILABLE 2

NO. OF PORTS USED 2

PORT INSIDE DIAMETER 4"

DISTANCE FROM FAR WALL TO OUTSIDE OF PORT 86"

NIPPLE LENGTH AND/OR WALL THICKNESS 10"

DEPTH OF STACK OR DUCT 76"

STACK OR DUCT WIDTH (IF RECTANGULAR) —

EQUIVALENT DIAMETER:

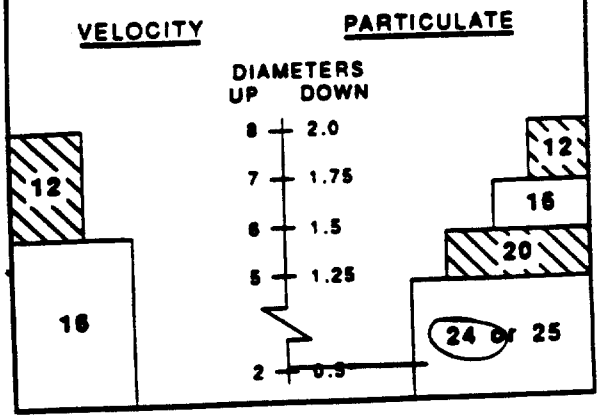
$D_E = \frac{2 \times \text{DEPTH} \times \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(\quad)(\quad)}{(\quad + \quad)} =$ —

DISTANCE FROM PORTS TO FLOW DISTURBANCES	UPSTREAM	DOWNSTREAM
	156"	120"
DIAMETERS	2.05	1.58

STACK/DUCT AREA = $\pi(\frac{76}{2})^2$ = 4536.5 IN²

DRAW HORIZONTAL LINE THROUGH DIAMETERS

If more than 8 and 2 diameters and if duct dia. is less than 24", use 8 or 9 points.



LOCATION OF POINTS IN CIRCULAR STACKS OR DUCTS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.8	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	18.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	28.6	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	78.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	68.4	60.7	39.8
13						94.3	87.5	81.2	75.0	68.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.8
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

LOCATION OF POINTS IN RECTANGULAR STACKS OR DUCTS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8

POINT	% OF DUCT DEPTH	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	2.1	1 5/8	11 5/8
2	6.7	5 1/8	15 1/8
3	11.8	9	19
4	17.7	13 1/2	23 1/2
5	25.0	19	29
6	35.6	27	37
7	64.4	49	55
8	75.0	57	63
9	82.3	62.5	72 1/2
10	88.2	67	77
11	93.3	70 7/8	80 7/8
12	97.9	74 3/8	84 3/8
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

SEE REVERSE FOR FIELD USE CHECKLIST

METHOD 3 (ORSAT) FIELD DATA

Plant Name/Address Camden CRRF Job No. 10280

Sampling Location Unit 1 SDA ~~out~~ inlet Fuel Type _____

Run/Sample No. 1-I-M3-1 Leak √ ✓ Date 8-27-91 Operator LCM

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
0830	1245	9.6	19.3	—	9.7	—	[redacted]
↓	1253	9.5	19.2	—	9.7	—	
1058	1305	9.5	19.2	—	9.7	—	
				Avg.	9.7	—	80.8

~~Orsat~~Bag 8 Avg. 9.5

I.D. _____

Run/Sample No. 1-I-M3-2 Leak √ ✓ Date 8-27-91 Operator [illegible]

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
1150	1640	8.5	19.0	—	10.5	—	[redacted]
↓	1650	8.4	19.1	—	10.7	—	
1456							
				Avg.	10.6	—	80.9

~~Orsat~~Bag 5 Avg. 8.5

I.D. 5

Run/Sample No. 1-I-M3-3 Leak √ ✓ Date 8-27-91 Operator [illegible]

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
16-20	2120	8.7	19.0	—	10.3		[redacted]
↓	2130	8.7	19.1	—	10.4		
1954	2140	8.7	19.0	—	10.3		
				Avg.	10.3		81.0

~~Orsat~~Bag Avg. 8.7

I.D. _____

(For field check of fuel type, refer to page 2)

ENTROPY

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Camden County Resource Recovery — RUN NUMBER 1-I-MMTL-1
ADDRESS Camden, NJ — TIME START 0830
SAMPLING LOCATION Unit 1 Inlet — TIME FINISH 1059
DATE 9-27-91 — TEAM LEADER WTL — TECHNICIANS ECS
BAROMETRIC PRESSURE. IN. HG 30.1 — STATIC PRESSURE IN. H_2O -2.2
TRAIN LEAK CHECK VACUUM IN. HG 15 (1st Pitot) / 15 — 15 / 7 / 16
TRAIN LEAK RATE, CU.FT/MIN .001 / .001 — .003 / .001 / .009

EQUIPMENT CHECKS
- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- ✓ M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE # 848 PRE
- ✓ THERMOCOUPLE # 400 POST

IDENTIFICATION NUMBERS
REAGENT BOX M125 — NOZZLE # 909 — DIAMETER .275
METER BOX N-10 Y .9948 — T/C READOUT F-23
UMBILICAL U-59 — T/C PROBE R-238
SAMPLE BOX 62 — ORSAT PUMP 26
PROBE 9-12 — PITOT 61 — TEDLAR BAG 6

LEAK CHECK READINGS

0	206.35 / 206.40
1	
2	735.615 / 735.65
3	
4	
5	
6	

FILTER #	TARE
Q1157	.4657
Q1170	

DELTA $H_@$	1.885			
METER TEMP	105			
EST. $\%H_2O$	15			
C FACTOR	.884			
STACK TEMP	425			
REF DELTA P	.585			
K-FACTOR	3.145			

FYRITE 9½ %
C_p .84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H_2O IDEAL	ORIFICE SETTING IN. H_2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES PROBE EXIT °F	GAS TEMPERATURES FILTER BOX °F	STACK TEMP. °F	LEAK CHK ✓
1	A1	0	697.875	.29	.95	.95	97	2	250	55	325	
2	2	5	700.62	.30	.99	.99	99	2	252	55	375	
3	3	10	703.35	.37	1.16	1.16	100	2	252	54	420	
4	4	15	706.83	.38	1.18	1.18	101	2	252	54	427	
5	5	20	709.33	.40	1.25	1.25	103	3	270	56	428	
6	6	25	712.39	.47	1.46	1.46	106	3	267	55	435	
7	7	30	715.71	.52	1.62	1.62	107	4	260	55	436	
8	8	35	719.19	.50	1.57	1.57	108	5	260	53	431	
9	9	40	722.67	.50	1.57	1.57	109	6	260	54	420	
10	10	45	726.20	.49	1.57	1.57	110	7	258	55	412	
11	11	50	729.61	.42	1.36	1.36	110	7	252	55	407	
12	12	55	732.80	.32	1.04	1.04	111	7	250	55	400	
13	B1	60/0	735.615	.33	1.06	1.06	107	5	250	58	407	
14	2	5	738.49	.33	1.06	1.06	108	6	250	57	453	
15	3	10	741.31	.40	1.22	1.22	108	6	250	57	458	
16	4	15	744.30	.46	1.39	1.39	109	8	250	56	464	
17	5	20	747.68	.45	1.37	1.37	101	10	250	56	464	
18	6	25	750.81	.46	1.40	1.40	111	10	250	57	461	
19	7	30	754.03	.52	1.66	1.66	112	12	250	58	423	
20	8	35	757.55	.50	1.63	1.63	112	13	250	58	402	
21	9	40	761.04	.56	1.81	1.81	112	15	252	56	411	
22	10	45	764.73	.43	1.42	1.42	112	15	252	56	389	
23	11	50	768.18	.46	1.52	1.52	112	16	252	56	392	
24	12	55	771.38	.47	1.55	1.55	113	16	252	56	394	
25		60	774.85									

Clogged Filter

STOP 0846
START 0902

Port change
0947
0958

1.37

120	76.890	.4270	1.36	108	420
minutes	Vs	$(\sqrt{\Delta p})^2$	ΔH	Ts	Ts

F1010
12/89
p1

ISOKINETIC TYPE FIELD DATA SHEET

15

COMPANY NAME Camden County Resource Recovery — RUN NUMBER I.E. mm TL-2
ADDRESS Camden, NJ. — TIME START 1150
SAMPLING LOCATION Cn.6 Inlet — TIME FINISH 1454
DATE 8-27-91 — TEAM LEADER WTC — TECHNICIANS ECS
BAROMETRIC PRESSURE. IN. HG 30.1 — STATIC PRESSURE IN. H_2O -2.2
TRAIN LEAK CHECK VACUUM IN. HG 15 (.002) 9 (.002) 15 (.002) 15 2nd (.002) 5 (.000)
TRAIN LEAK RATE, CU.FT/MIN

EQUIPMENT CHECKS
- PITOTS, PRETEST
- PITOTS, POSTTEST
- M3 SAMPLING SYS/TED BAG
- THERMOCOUPLE # 91 PRE
- THERMOCOUPLE # 396 POST

IDENTIFICATION NUMBERS
REAGENT BOX M135 — NOZZLE 6487 — DIAMETER .266
METER BOX N-10 Y .9948 — T/C READOUT F-23
UMBILICAL C-59 — T/C PROBE R-255
SAMPLE BOX 10 — ORSAT PUMP 26
PROBE S-4 — PITOT S-4 — TEDLAR BAG 5

LEAK CHECK READINGS

5	810.475
1	810.535
2	831.524
3	831.644
4	846.808
5	846.852

FILTER #	TARE
Q1156	
Q1172	

DELTA $H_@$	1.855			
METER TEMP	110			
EST. ΔH_2O	15			
C FACTOR	.984			
STACK TEMP	425			
REF DELTA P	.669			
K-FACTOR	2.253			

FYRITE 9% — C_{pv} 84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H_2O IDEAL	ORIFICE SETTING IN. H_2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES PROBE °F	GAS TEMPERATURES EXIT °F	STACK TEMP. °F	LK CHK #
1	A1	0	776.013	.23	.67	.67	103	1	270	60	375	
2	2	5	778.51	.29	.82	.82	100	2	270	55	396	
3	3	10	780.93	.36	.89	.89	102	2	250	52	420	
4	4	15	783.73	.37	1.01	1.01	103	2	250	51	429	
5	5	20	786.52	.45	1.22	1.22	106	2	249	52	439	
6	6	25	789.55	.54	1.45	1.45	107	2	250	50	446	
7	7	30	792.84	.54	1.45	1.45	109	3	240	48	454	
8	8	35	796.16	.45	1.22	1.22	110	3	245	49	440	
9	9	40	799.22	.34	.93	.95	112	4	250	48	417	
10	10	45	801.95	.37	1.04	1.04	112	4	250	46	445	
11	11	50	804.73	.38	1.08	1.08	112	6	250	46	405	
12	12	55	807.62	.37	1.04	1.04	112	6	250	45	415	
13	B1	60/0	810.535	.31	.91	.91	111	4	260	59	380	
14	2	5	813.10	.32	.91	.91	112	5	250	49	408	
15	3	10	815.74	.52	1.40	1.40	112	6	252	56	454	
16	4	15	818.78	.30	.81	.81	112	6	252	55	451	
17	5	20	821.33	.48	1.28	1.28	112	9	252	50	462	
18	6	25	824.44	.39	1.05	1.05	114	9	250	48	483	
19	7	30	827.36	.65	1.78	1.78	114	10	250	46	441	
20	8	35	830.90	.58	1.61	1.61	115	15	250	45	428	
21	9	40	834.54	.44	1.25	1.25	112	1	225	52	403	
22	10	45	837.67	.50	1.42	1.42	113	2	230	53	407	
23	11	50	840.86	.38	1.08	1.08	114	2	235	55	406	
24	12	55	843.77	.41	1.18	1.18	113	3	240	56	396	
25		60	846.808									

STOP Port change 1250
START 1305
STOP 1411

(Filter) START 1430

120 minutes — 70.571 Vs — .4095 $(\sqrt{\Delta p})^2$ — 1.15 ΔH — 110 Ts — 422.5 Ts

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ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Camden County Resource Recovery — RUN NUMBER 1-I-MMTL-3
ADDRESS Camden, N.J. — TIME START 1628
SAMPLING LOCATION UNIT 1 Inlet — TIME FINISH 1954
DATE 8-27-91 — TEAM LEADER MTL — TECHNICIANS TCS
BAROMETRIC PRESSURE. IN. HG 30.1 — STATIC PRESSURE IN. H_2O -2.2
TRAIN LEAK CHECK VACUUM IN. HG 15 (15 .006) 15 .008 (15 .001) 2nd 6 .005 16 .002 (15 .002) .002
TRAIN LEAK RATE, CU.FT/MIN .002

EQUIPMENT CHECKS
- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- ✓ M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE # 97 PRE
- ✓ THERMOCOUPLE # 404 POST

IDENTIFICATION NUMBERS
REAGENT BOX M125 — NOZZLE G164 — DIAMETER .274
METER BOX 10 Y .9948 — T/C READOUT K23
UMBILICAL U-59 — T/C PROBE B127
SAMPLE BOX T5 61 — ORSAT PUMP 26
PROBE S-2 — PITOT 33 — TEDLAR BAG 10

LEAK CHECK READINGS
0 865.763
1 ~~865.247~~
2 865.394
3 886.523
4 886.641
5 909.518
6 ~~909.600~~
7 ~~909.518~~
8 910.131
9 ~~910.224~~

FILTER #	TARE
Q1154	untared

DELTA $H_@$	1.885			
METER TEMP	110			
EST. $\%H_2O$	15			
C FACTOR	~~.992~~			
STACK TEMP	425			
REF DELTA P	.588			
K-FACTOR	3.127			

FYRITE 10.9%
C_p .84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H_2O THEOR.	ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES PROBE °F	EXIT °F	STACK TEMP. °F	LEAK CHK #
1	A 1	0	847.388	.23	.77	.77	108	2	225	60	325	
2	2	5	850.11	.30	1.00	1.00	109	2	250	~~48~~	363	
3	3	10	852.90	.41	1.29	1.29	110	3	250	47	418	
4	4	15	855.95	.35	1.1	1.1	110	4	245	~~48~~	421	
5	5	20	858.82	.41	1.28	1.28	112	7	248	50	429	
6	6	25	861.93	.44	1.37	1.37	112	13	248	50	432	
7	7	30	865.163	.50	1.54	1.54	111	15	250	50	435	
8	B	35	~~868.86~~	.55	1.69	1.69	112	3	248	46	441	
9	9	40	872.42	.50	1.57	1.57	113	4	250	45	424	
10	10	45	875.85	.54	1.8	1.8	114	5	2600	47	424	
11	11	50	879.57	.52	1.64	1.64	114	5	270	48	419	
12	12	55	883.13	.47	1.49	1.49	114	6	270	49	418	
13	B 1	~~60~~	886.523	.41	1.24	1.24	111	5	275	54	450	
14	2	5	889.68	.48	1.46	1.46	111	6	270	54	450	
15	3	10	892.99	.58	1.72	1.72	111	8	260	52	470	
16	4	15	896.59	.65	1.92	1.92	112	10	250	55	478	
17	5	20	900.37	.81	2.38	2.38	113	12	248	57	485	
18	6	25	904.47	.87	2.56	2.56	114	14	240	58	495	
19	7	30	908.75	~~.98~~	~~2.85~~	~~2.88~~	115	16	246	58	474	
20	8	35	913.00	.58	1.82	1.82	107	4	250	46	444	
21	9	40	916.76	.62	1.96	1.96	109	6	250	48	440	
22	10	45	920.59	.57	1.81	1.81	111	7	250	49	440	
23	11	50	924.35	.56	1.79	1.77	112	7	250	50	406	
24	12	55	927.96	.49	1.57	1.57	112	8	250	52	404	
25	OFF	60	931.409									

STOP 16.50 (Filter) START 1710
STOP 1740
START 1810
STOP 1841
START 1920
STOP 1954

120 minutes — 82-859 V_m — .5085 $(\sqrt{\Delta p})^2$ — 1.61 ΔH — 112 T_m — 428 T_s

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APPENDIX B.2

B. FIELD DATA

2. Stack

Sampling and Velocity Traverse Point Determination
EPA Method 1

PLANT NAME [redacted] Camden Co RRF

CITY, STATE Camden, NJ

SAMPLING LOCATION Unit #1, 2, 3 Stacks

NO. OF PORTS AVAILABLE 2

NO. OF PORTS USED 2

PORT INSIDE DIAMETER 4"

DISTANCE FROM FAR WALL TO OUTSIDE OF PORT 79

NIPPLE LENGTH AND/OR WALL THICKNESS 7

DEPTH OF STACK OR DUCT 72

STACK OR DUCT WIDTH (IF RECTANGULAR) NA

EQUIVALENT DIAMETER:

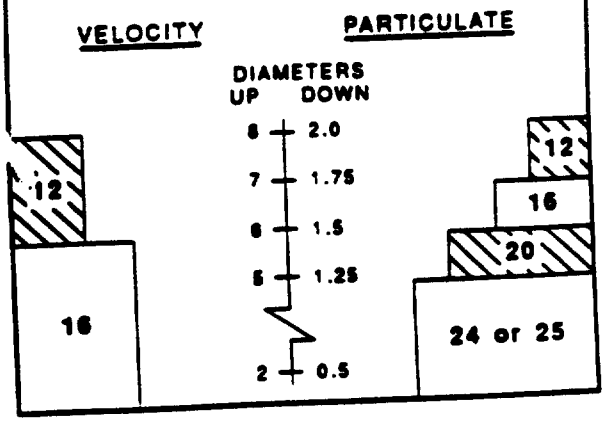
$D_E = \frac{2 \times \text{DEPTH} \times \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(\quad)(\quad)}{(\quad + \quad)} =$ NA

DISTANCE FROM PORTS TO FLOW DISTURBANCES	UPSTREAM	DOWNSTREAM
	~80'	~150'
DIAMETERS	13.33	25

STACK/DUCT AREA = $\pi(72/2)^2$ = 4071.50 IN²

DRAW HORIZONTAL LINE THROUGH DIAMETERS

If more than 8 and 2 diameters and if duct dia. is less than 24", use 8 or 9 points.



LOCATION OF POINTS IN CIRCULAR STACKS OR DUCTS

	4	(6)	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	8.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.6	22.0	18.8	16.5	14.8	13.2
7			89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.8	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	75.0	66.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.6	92.1
22										98.9	94.5
23											96.8
24											98.9

LOCATION OF POINTS IN RECTANGULAR STACKS OR DUCTS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8

POINT	% OF DUCT DEPTH	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	4.4	3.17"	10.17"
2	14.6	10.51	17.51
3	29.6	21.31	28.31
4	70.4	50.69	57.69
5	85.4	61.49"	68.49"
6	95.6	68.8"	75.83"
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

SEE REVERSE FOR FIELD USE CHECKLIST

F-0016
10-90

METHOD 3 (ORSAT) FIELD DATA

Plant Name/Address Camden Co. RRF Camden NJ Job No. 10280 19

Sampling Location Unit 1 stack Fuel Type _____

Run/Sample No. 1-S-M3-1 Leak √ Date 8-27-91 Operator JCM

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
0830	1210	8.5	19.4	—	10.9	—	[redacted]
↓	1220	8.5	19.3	—	10.8	—	
1058	1230	8.5	19.4	—	10.9	—	
	Avg.	8.5		Avg.	10.9	—	80.6

~~Orsat~~ Bag I.D. Bag-6

Run/Sample No. 1-S-M3-2 Leak √ Date 8-27-91 Operator JCM

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
1150	1530	8.5	19.0	—	10.5	—	[redacted]
↓	1540	8.4	18.9	—	10.5	—	
1451	1550	8.5	19.0	—	10.5	—	
	Avg.	~~8.5~~ 8.4		Avg.	10.5	—	~~81.0~~ 81.1

~~Orsat~~ Bag I.D. 7

Run/Sample No. 1-S-M3-3 Leak √ Date 8-27-91 Operator JCM

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
1620	2045	8.5	19.1	—	10.6	—	[redacted]
↓	2055	8.5	19.1	—	10.6	—	
1952	2105	8.5	19.1	—	10.6	—	
	Avg.	8.5		Avg.	10.6	—	80.9

~~Orsat~~ Bag I.D. 23

(For field check of fuel type, refer to page 2)

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME FOSTER WHEELER CAMDEN COUNTY RRF Job # 10280 RUN NUMBER 1-5-MATL-20
ADDRESS CAMDEN, NEW JERSEY TIME START 830
SAMPLING LOCATION UNIT 1 STACK TIME FINISH 1058
DATE 08-27-91 TEAM LEADER WEM TECHNICIANS LCM
BAROMETRIC PRESSURE. IN. HG 30.0 STATIC PRESSURE IN. H_2O -.20
TRAIN LEAK CHECK VACUUM IN. HG 17 10 10 — — —
TRAIN LEAK RATE, CU.FT/MIN .002 .003 .003 — — —

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- ✓ M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE # 84 PRE
- ✓ THERMOCOUPLE # 96 POST

IDENTIFICATION NUMBERS

REAGENT BOX M183 NOZZLE SS-9 DIAMETER .270
METER BOX N-49 Y .9723 T/C READOUT F09
UMBILICAL N90 T/C PROBE R207
SAMPLE BOX 48 ORSAT PUMP 28
PROBE 8-49 PITOT 58 TEDLAR BAG 8

LEAK CHECK READINGS

1	551.061
2	551.119
3	
4	
5	
6	

FILTER #	TARE
UNCACHED	QUARTZ

DELTA $H_@$ 1.773
METER TEMP 100
EST. $\%H_2O$ 18%
C FACTOR 0.780
STACK TEMP 255
REF DELTA P 0.585
K-FACTOR 3.147

FYRITE 8.5 9

C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H_2O IDEAL	ORIFICE SETTING IN. H_2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES PROBE BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	A-1	0	504.930	0.47	1.46	1.46	84	6	255	66	253	
2		5	510.829	0.51	1.57	1.57	85	7	255	66	262	
3	-2	10	513.921	0.49	1.52	1.52	86	7	255	65	259	
4		15	517.459	0.47	1.46	1.46	87	7	256	64	259	
5	-3	20	520.889	0.49	1.53	1.53	88	7	256	63	258	
6		25	524.459	0.52	1.62	1.62	89	7	255	62	259	
7	-4	30	528.115	0.56	1.74	1.74	90	7	256	62	260	
8		35	531.929	0.53	1.65	1.65	91	7	255	61	261	
9	-5	40	535.689	0.61	1.90	1.90	92	8	254	61	262	
10		45	539.681	0.60	1.87	1.87	93	8	253	62	263	
11	-6	50	543.655	0.54	1.69	1.69	94	7	253	62	263	
12		55	547.432	0.49	1.53	1.53	95	7	252	61	264	
13	B-1	60/0	551.061	0.48	1.50	1.50	92	6	253	65	258	✓
14		5	554.621	0.50	1.56	1.56	93	6	252	64	262	
15	-2	10	558.224	0.45	1.41	1.41	94	6	253	64	262	
16		15	561.671	0.51	1.60	1.60	95	7	252	63	261	
17	-3	20	565.389	0.47	1.48	1.48	96	7	251	64	261	
18		25	569.021	0.44	1.39	1.39	97	7	250	64	261	
19	-4	30	572.371	0.36	1.14	1.14	98	5	250	63	261	
20		35	575.575	0.45	1.43	1.43	99	5	251	62	260	
21	-5	40	578.895	0.61	1.93	1.93	99	6	252	62	259	
22		45	582.895	0.46	1.45	1.45	99	6	253	63	260	
23	-6	50	586.511	0.51	1.62	1.62	100	7	253	63	259	
24		55	590.225	0.48	1.52	1.52	100	7	254	62	259	
25		60/end	593.875	N/A	N/A	N/A	N/A	N/A	N/A	N/A		

120 minutes | 86887 Vm | .4984 $(\sqrt{\Delta p})^2$ | 1.57 ΔH | 93 tm

260 ts

F1010 12/89 p1

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME FOSTER WHEELER CAMDEN COUNTY RRF Job# 10280 RUN NUMBER 1-S-MM5-2
ADDRESS CAMDEN, NEW JERSEY TIME START 1150
SAMPLING LOCATION UNIT 1 STACK TIME FINISH 1451
DATE 08-27-91 TEAM LEADER WEM TECHNICIANS LCM
BAROMETRIC PRESSURE. IN. HG 30.0 STATIC PRESSURE IN. H_2O -.30
TRAIN LEAK CHECK VACUUM IN. HG 15" 10" 8"
TRAIN LEAK RATE, CU.FT/MIN .004 .003 .002 (P)

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- ✓ M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 86 PRE
- ✓ THERMOCOUPLE @ 86 POST

IDENTIFICATION NUMBERS

REAGENT BOX M133 NOZZLE S685 DIAMETER .270
METER BOX M119 Y .9723 T/C READOUT [illegible]
UMBILICAL U90 T/C PROBE [illegible]
SAMPLE BOX 61 ORSAT PUMP 28
PROBE B-10 PITOT 57 TEDLAR BAG 7

LEAK CHECK READINGS

1	638.302
1	638.353
2	
3	
4	
5	
6	

FILTER #	TARE
UNLOADED	QUARTZ

DELTA $H_@$	1.773					
METER TEMP	110					
EST. $\%H_2O$	18%					
C FACTOR	0.793					
STACK TEMP	~~255~~ 265					
REF DELTA P	0.575					
K-FACTOR	3.203					

FYRITE 8.0 7.5 C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #	
1	A-1	0	594.065	0.39	1.23	1.23	93	2	251	66	258		
2		5	597.315	0.56	1.76	1.76	94	2	250	65	261		
3	-2	10	601.165	0.50	1.57	1.57	95	2	249	65	261		
4		15	604.815	0.46	1.45	1.45	96	2	249	66	261		
5	-3	20	608.329	0.49	1.54	1.54	97	2	248	65	261		
6		25	611.942	0.45	1.42	1.42	98	2	247	64	261		
7	-4	30	615.441	0.66	2.08	2.08	99	3	248	64	262		
8		35	619.675	0.57	1.80	1.80	100	3	248	63	263		
9	-5	40	623.555	0.47	1.49	1.49	101	3	249	62	262		
10		45	627.171	0.49	1.56	1.56	102	3	250	62	262		
11	-6	50	630.871	0.45	1.43	1.43	103	3	250	63	261		
12		55	634.371	0.56	1.79	1.79	104	3	251	63	261		
13	A-1	60/0	638.302	0.56	1.77	1.77	100	3	252	65	260	✓	STOP 1250 START 1305
14		5	642.295	0.56	1.77	1.77	101	3	252	65	262		
15	-2	10	646.175	0.53	1.68	1.68	102	3	251	64	263		
16		15	649.972	0.48	1.52	1.52	98	3	254	67	260		STOP 1316 START 1345
17	-3	20	653.565	0.44	1.39	1.39	99	3	254	66	259		
18		25	657.035	0.56	1.77	1.77	99	3	253	65	261		
19	-4	30	660.949	0.48	1.52	1.52	100	3	252	64	260		STOP 1440 START 1490
20		35	664.795	0.64	2.03	2.03	100	3	253	64	261		
21	-5	40	668.619	0.65	2.05	2.05	99	3	254	66	262		
22		45	672.721	0.47	1.48	1.48	97	3	255	68	262		STOP 1451
23	-6	50	676.295	0.55	1.74	1.74	98	3	255	67	258		
24		55	680.109	0.47	1.49	1.49	99	3	254	66	259		
25		60/OFF	683.729	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		

120	89.613	.5161	1.64	99	261
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010
12/89
p1

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME FOSTER WHEELER CAMDEN COUNTY RRF Job # 10280 RUN NUMBER 1-5-mm-3
ADDRESS CAMDEN NEW JERSEY TIME START 1620
SAMPLING LOCATION 300 FT 1 STACK TIME FINISH 1952
DATE 08-27-91 TEAM LEADER WEM TECHNICIANS LCM
BAROMETRIC PRESSURE. IN. HG 30.0 STATIC PRESSURE IN. H_2O -.25
TRAIN LEAK CHECK VACUUM IN. HG 16 8 8
TRAIN LEAK RATE, CU.FT/MIN .007 .003 .002

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- ✓ M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 90° PRE
- ✓ THERMOCOUPLE @ 92° POST

IDENTIFICATION NUMBERS

REAGENT BOX M133 NOZZLE B-5 DIAMETER .270
METER BOX M119 Y .9723 T/C READOUT
UMBILICAL 490 T/C PROBE 239
SAMPLE BOX 55 ORSAT PUMP 28
PROBE 8-11 PITOT 8-11 TEDLAR BAG 23

LEAK CHECK READINGS

0	731.800
1	731.872
2	
3	
4	
5	
6	

FILTER #	TARE
DESTRATED	QUARTZ

DELTA $H_@$	1.773		
METER TEMP	110		
EST. $\%H_2O$	18%		
C FACTOR	0.793		
STACK TEMP	265		
REF DELTA P	0.574		
K-FACTOR	3.203		

FYRITE 9 9 8.5 8.4
C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H_2O IDEAL	ORIFICE SETTING IN. H_2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	A-1	0	684.161	0.60	1.89	1.89	100	2	250	67	2666	
2		5	688.285	0.58	1.83	1.83	100	2	249	67	263	
3	-2	10	692.125	0.56	1.77	1.77	101	2	249	66	262	
4		15	696.035	0.54	1.72	1.72	102	2	250	65	261	
5	-3	20	699.865	0.57	1.82	1.82	103	2	251	65	259	
6		25	703.815	0.56	1.79	1.79	104	2	251	64	258	
7	-4	30	707.770	0.61	1.95	1.95	105	2	252	66	259	
8		35	711.869	0.65	2.06	2.06	103	2	255	65	264	
9	-5	40	715.989	0.55	1.74	1.74	103	2	254	65	263	
10		45	719.871	0.70	2.23	2.23	104	3	255	64	262	
11	-6	50	724.261	0.52	1.66	1.66	104	2	255	64	261	
12		55	728.061	0.50	1.60	1.60	105	2	256	63	261	LK
13	B-1	60/0	731.806	0.51	1.62	1.62	100	2	255	65	260	
14		5	735.625	0.61	1.93	1.93	101	2	256	65	261	
15	-2	10	739.735	0.63	2.0	2.0	102	2	255	64	261	
16		15	743.895	0.71	2.56	2.56	103	2	256	64	263	
17	-3	20	748.349	0.65	2.06	2.06	104	2	255	63	264	
18		25	752.489	0.81	2.56	2.56	104	2	254	64	267	
19	-4	30	757.210	0.99	3.12	3.12	105	2	253	63	266	
20		35	761.471	0.73	2.30	2.30	98	2	254	64	261	
21	-5	40	765.944	0.67	2.11	2.11	99	2	253	63	262	
22		45	770.169	0.70	2.22	2.22	100	2	252	62	260	
23	-6	50	774.515	0.57	1.81	1.81	101	2	252	62	260	
24		55	778.471	0.62	1.97	1.97	102	2	253	63	261	
25		60/OFF	782.593	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

120 minutes | 98.3 dc Vm | .6160 $(\sqrt{\Delta p})^2$ | 1.96 ΔH | 102 tm | 261 ts

F1010
12/89
pl

APPENDIX C

ANALYTICAL DATA

MOISTURE SAMPLING LABORATORY RESULTS

Plant Name: CAMDEN CO. RESOURCE RECOVERY FACILITY EEI Ref# 10280

Sampling Location: Unit No. 1 SDA Inlet

Date Received: 8/29 Date Analyzed: 8/29 Reagent Box(es): M125

Run Number Run Date	1-I-MMTL-1 8/27	1-I-MMTL-2 8/27	1-I-MMTL-3 8/27
ANALYSIS OF MOISTURE CATCH			
Reagent 1 (5% HNO3/10% H2O2)			
Final Weight, g.	556.5	511.5	559.0
Tared Weight, g.	269.5	270.5	269.0
Water Catch,g.	287.0	241.0	290.0
Reagent 2 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch,g.	0.0	0.0	0.0
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch,g.	0.0	0.0	0.0
CONDENSED WATER, g.	287.0	241.0	290.0
Silica Gel:			
Final Weight, g.	218.5	217.5	219.5
Tared Weight, g.	200.0	200.0	200.0
ADSORBED WATER, g.	18.5	17.5	19.5
TOTAL WATER COLLECTED, g.	305.5	258.5	309.5

MOISTURE SAMPLING LABORATORY RESULTS

Plant Name: CAMDEN CO. RESOURCE RECOVERY FACILITY EEI Ref# 10280

Sampling Location: Unit No. 1 Stack

Date Received: 8/29 Date Analyzed: 8/29 Reagent Box(es): M133

Run Number	1-S-MMTL-1	1-S-MMTL-2	1-S-MMTL-3
Run Date	8/27	8/27	8/27
ANALYSIS OF MOISTURE CATCH			
Reagent 1 (5% HNO3/10% H2O2)			
Final Weight, g.	664.0	648.0	697.5
Tared Weight, g.	268.5	260.5	269.5
Water Catch, g.	395.5	387.5	428.0
Reagent 2 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.	0.0	0.0	0.0
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.	0.0	0.0	0.0
CONDENSED WATER, g.	395.5	387.5	428.0
Silica Gel:			
Final Weight, g.	214.5	225.5	219.5
Tared Weight, g.	200.0	200.0	200.0
ADSORBED WATER, g.	14.5	25.5	19.5
TOTAL WATER COLLECTED, g.	410.0	413.0	447.5

Oxford Laboratories, Inc.
Analytical and Consulting Chemists
1316 South Fifth Street
Wilmington, N.C. 28401
(919) 763-9793

DATE RECEIVED 9-03-91
DATE REPORTED 9-19-91
91W2663

ENTROPY ENVIRONMENTALIST INC.
P. O. BOX 12291
RESEARCH TRIANGLE PARK, NC 27709-2291

P.O. # 1613-10280

ATTENTION: RICHARD TEBEAU

SAMPLE DESCRIPTION: MMTL

7. 1-I-MMTL-1
8. 1-I-MMTL-2
9. 1-I-MMTL-2 DUPLICATE
10. 1-I-MMTL-3
11. 1-I-MMTL-3 SPIKE
12. 1-I-MMTL-FB

RESULTS

	7	8	9	10	11	12
Lead, as Pb, Total ug	36400	46800	46600	47000	95.0%	<20.0

Oxford Laboratories, Inc.

Analytical and Consulting Chemists
1316 South Fifth Street
Wilmington, N.C. 28401
(919) 763-9793

DATE RECEIVED 9-03-91
DATE REPORTED 9-19-91
91W2663

ENTROPY ENVIRONMENTALIST INC.
P. O. BOX 12291
RESEARCH TRIANGLE PARK, NC 27709-2291

P.O. # 1613-10280

ATTENTION: RICHARD TEBEAU

SAMPLE DESCRIPTION: MMTL

1. 1-S-MMTL-1
2. 1-S-MMTL-2
3. 1-S-MMTL-2 DUPLICATE
4. 1-S-MMTL-3
5. 1-S-MMTL-3 SPIKE
6. 1-S-MMTL-FB

RESULTS

	1	2	3	4	5	6
Lead, as Pb, Total ug	<20.0	<20.0	<20.0	22600	100%	<20.0

Oxford Laboratories, Inc.
Analytical and Consulting Chemists
1316 South Fifth Street
Wilmington, N.C. 28401
(919) 763-9793

DATE RECEIVED 9-03-91
DATE REPORTED 9-19-91
91W2663

ENTROPY ENVIRONMENTALIST INC.
P. O. BOX 12291
RESEARCH TRIANGLE PARK, NC 27709-2291

P.O. # 1613-10280

ATTENTION: RICHARD TEBEAU

SAMPLE DESCRIPTION: MMTL

13. BLANK
14. METHOD CODE SW846

RESULTS

	13	14
Lead, as Pb, Total ug	<20.0	7420

ROGER C. OXFORD, CHEMIST

A.A. SUMMARY REPORT

CLIENT: ENTROPY
P.O.#/PROJECT #:1613-10280
ANALYST: KEN SMITH
DATE: 09/11/91

X .100 WT. STDS
1 CONC STDS
1.00 INST LIMIT
.1 SPK LEVEL
F.V. MAX ALIQUO
X M.D.L.

SAMPLE I.D.	EL	MEAN ABS	ug/ml CONC	SAMPLE ALIQUOT	DILUTION		TOTAL ug ANSWER	% REC OR <
2663-01	Pb	.0005663	.06	1	200	<		20
2663-03	Pb	.00035	.04	1	200	<		20
2663-06	Pb	.0000379	0	1	200	<		20
2663-07	Pb	.1017233	9.09	1	4000		36360	
AS Position 3	Pb	.0444623	4.03	0	0			
Blank	Pb	-.000279	-.02	0	0			
Blank	Pb	-.000147	-.02	0	0			
PE KNOWN	Pb	.0103932	1	1	1		1	
Std 1=.50ug/ml	Pb	.0049425	.005	0	0			
Std 2=4.0ug/ml	Pb	.0441167	4.46	0	0			
Std 3=10.0ug/ml	Pb	.1120541	8.61	0	0			
Std Blank	Pb	-.056398	-.056	0	0			
2663-02	Pb	.000622	.05	1	200	<		20
2663-04	Pb	.066301	5.64	1	4000		22560	
2663-05-#4SPK	Pb	.0445514	3.82	1	8000		30560	100
2663-08	Pb	.0548778	4.68	1	10000		46800	
2663-09	Pb	.0546103	4.66	1	10000		46600	
2663-10	Pb	.0551119	4.7	1	10000		47000	
2663-011-#10SPK	Pb	.038394	3.3	1	20000		66000	95
2663-12	Pb	.0007647	.07	1	200	<		20
2663-13	Pb	.0001382	.01	1	200	<		20
AS Position 3	Pb	.0471999	4.04	0	0			
AS Position 3	Pb	.0468009	4	0	0			
AS Position 3	Pb	.0464821	3.98	0	0			
Blank	Pb	.00042B	.04	0	0			
Blank	Pb	-.000564	-.05	0	0			
Std 1=.50ug/ml	Pb	.0056849	.57	0	0			
Std 2=4.0ug/ml	Pb	.0476636	4.19	0	0			
Std 3=10.0ug/ml	Pb	.118954	9.26	0	0			
Std Blank	Pb	.0004637	.05	0	0			

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. M125 Assembly Date 9/23 Assembled By VP

Plant Name/Address FOLTZ WISSLER Job No. 10270-1

Sampling Loc. UNIT 1 [redacted] INLET Method MM7L-Pb

Individual Tare of Reagent 200 (mL)(gm) of 5% HNO_3/10% H_2O_2

Individual Tare of Reagent _____ (mL)(gm) of _____

Individual Tare of Reagent _____ (mL)(gm) of _____

Individual Tare of Sil. Gel 200 gm _____ -- Other (specify)

Run Number	Run Date	Filter Number	Filter Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
1-I-MM7L-1	9-27	2/4	2/4	yes	[illegible]	9/27	55	yes	[illegible]
1-I-MM7L-2				yes	[illegible]	8/27	50	yes	[illegible]
1-I-MM7L-3	9/27			yes	[illegible]	8/27	100	yes	[illegible]

Filter Appearance* 2 filters HEAVY ASH ON PARTICULATE

Reagents Appearance* CLEAR

Filter Appearance* HEAVY Particulate → DAMP FILTER (WET?) 2 filters

Reagents Appearance* Clear

Filter Appearance* " - slightly damp (2nd filter) 2 filters

Reagents Appearance* "

Filter Appearance*

Reagents Appearance*

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ✓ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS Particulate load was so great that 200ml of .1N H_2O_2 was added to the rinse for the Fit & three Trains

6-29-91 DP.

ENTROPY

RECORD OF CUSTODY, CONTAINER NO. M125

Container Type (check) X Reagent Box __Cooler __Other (specify) _____

Plant Name/Address Foster Wheeler - Camden

Job No. 10280-1 Sampling Method MMTL-A (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
813	8/23	8:54	S	Vera Pressley	
	8/26	8:00	B	[illegible]	Change Hands
817	8/27	9:00	S	[illegible]	Go Home!
	E-29	10:00	B	Don P.	Custody
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Relinq'd By _____ Date _____ Time _____ Rec'd By Don Porter 8-29-91

Relinq'd By _____ Date _____ Time _____ Rec'd By _____

Relinq'd By _____ Date _____ Time _____ Rec'd By _____

As Applicable:
All liquid levels at mark (check)? ___ YES ___ NO (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:
TUBE SAMPLES put in freezer by _____ Date _____ Time _____

CONDENSATE SAMPLES put in refrige. by _____ Date _____ Time _____

REMARKS _____

L-0023 6-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. M133 Assembly Date 8/23 Assembled By VP

Plant Name/Address Foster Wheeler-Canada Job No. 10280-1

Sampling Loc. UNIT 1-STACK Method

Individual Tare of Reagent 200 (mL) ~~(gm)~~ of 5% HNO_3 / 10% H_2O_2

Individual Tare of Reagent ____ (mL)(gm) of ____

Individual Tare of Reagent ____ (mL)(gm) of ____

Individual Tare of Sil. Gel 200 gm ____ -- Other (specify)

Run Number	Run Date	Filter Number	Filter Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
1-S-MMTL-1	8-27	N/A	N/A	Yes	HR	8/27	50%	Yes	HR
1-S-MMTL-2	8-27			Yes	HR	8/27	50%	Yes	HR
1-S-MMTL-3	8-27	↓	↓	Yes	HR	8/27	50%	Yes	HR

Filter Appearance* Clear

Reagents Appearance* Clear

Filter Appearance* Clear

Reagents Appearance* Clear

Filter Appearance* Clear

Reagents Appearance* Clear

Filter Appearance*

Reagents Appearance*

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS 8-29-91 DP

RECORD OF CUSTODY, CONTAINER NO. M133

Container Type (check) X Reagent Box __Cooler __Other (specify) _____

Plant Name/Address Foster Wheeler - Camden

Job No. 10280 Sampling Method MMTC (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
814	8/[illegible]	8:56	S	Vera Bradley	
	8/20	8:05	B	[illegible]	Change Team
819	8/20	9:30	S	[illegible]	
	8-20	10:00	B	Don Porter	Custody
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Relinq'd By _____ Date _____ Time _____ Rec'd By 8-24-91 D.P.

Relinq'd By _____ Date _____ Time _____ Rec'd By _____

Relinq'd By _____ Date _____ Time _____ Rec'd By _____

As Applicable:
All liquid levels at mark (check)? ___ YES ___ NO (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:
TUBE SAMPLES put in freezer by _____ Date _____ Time _____

CONDENSATE SAMPLES put in refrige. by _____ Date _____ Time _____

REMARKS _____

L-0023 6-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. M123 Assembly Date 8/23 Assembled By VP

Plant Name/Address Forge Laboratories - Cambridge Job No. _____

Sampling Loc. UNIT 1 [redacted] INLET + STACK Method _____

Individual Tare of Reagent 200 (mL) (gm) of 5% HNO_3 / 10% H_2O_2

Individual Tare of Reagent _____ (mL) (gm) of _____

Individual Tare of Reagent _____ (mL) (gm) of _____

Individual Tare of Sil. Gel 200 gm _____ Other (specify)

Run Number	Run Date	Filter Number	Filter Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
1-I-Mon-FB	8/27	N/A	N/A	Yes	[redacted]	8/27	0	Yes	[redacted]
1-S-Mon-FB	8/27			Yes	[redacted]	8/27	0	Yes	[redacted]

Filter Appearance* Clear

Reagents Appearance* "

Filter Appearance* Clear

Reagents Appearance* "

Filter Appearance*

Reagents Appearance*

Filter Appearance*

Reagents Appearance*

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

8-29-91 DP

REMARKS _____

ENTROPY

RECORD OF CUSTODY, CONTAINER NO. M123

Container Type (check) X Reagent Box __Cooler __Other (specify) _____

Plant Name/Address Foster Wheeler - Camden

Job No. _____ Sampling Method _____ (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
	8/23	8:50	S	Vina Pressley	
8/2	8/27	7:30	B	[illegible]	Change Trains
	8/27	7:05	S	[illegible]	GO HOME
8/6	8-29	10:00	B	Don Patch	Custody
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Relinq'd By _____ Date _____ Time _____ Rec'd By DP 8-28-91

Relinq'd By _____ Date _____ Time _____ Rec'd By _____

Relinq'd By _____ Date _____ Time _____ Rec'd By _____

As Applicable:
All liquid levels at mark (check)? ___ YES ___ NO (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:
TUBE SAMPLES put in freezer by _____ Date _____ Time _____

CONDENSATE SAMPLES put in refrige. by _____ Date _____ Time _____

REMARKS _____

L-0023 6-91

ENTROPY

ENTROPY
Environmentalists, Inc.

P.O. Box 12291
Research Triangle Park
North Carolina 27709-2291
919-781-3550 FAX 919-787-8442

REQUEST FOR ANALYSIS

PO#: 1613-10280

Customer Name: Foster Wheeler
Camden, NJ

Laboratory: OLI

Date Transmitted: 8/29/91

Results Due By: 9/13/91

Sample Matrix: MMTL

Analysis: Analyze for Pb by MMTL method.

Sample #	Sample ID	Components/Comments
1	1-S-MMTL-1	-FH,-BH,-F,-R
2	1-S-MMTL-2	-FH,-BH,-F,-R
3	1-S-MMTL-2 dup	Duplicate analysis
4	1-S-MMTL-3	-FH,-BH,-F,-R
5	1-S-MMTL-3 sp	Matrix spike
6	1-S-MMTL-FB	-FH,-BH,-F,-R
7	1-I-MMTL-1	-FH,-BH,-F,-R
8	1-I-MMTL-2	-FH,-BH,-F,-R
9	1-I-MMTL-2 dup	Duplicate analysis
10	1-I-MMTL-3	-FH,-BH,-F,-R
11	1-I-MMTL-3 sp	Matrix spike
12	1-I-MMTL-FB	-FH,-BH,-F,-R
13	Blank	Reagent, Filter, HNO3

Submitted By: _____

INTERLABORATORY SAMPLE TRANSFER
RECORD OF CUSTODY

Please include this form with the final (typed) results, and whenever the final results are faxed.

The samples referenced in Entropy Environmentalists Inc. purchase order No. 1613-10280 were shipped via Pony on 8/29 to OLI by JVS.

The samples were received at OLI on 9-3-91 by MBC.

Note any broken seals, leakage, spillage, or damage to samples (*if discrepancy, indicate seal No., jar No., sample No., etc.*).

APPENDIX D

CALIBRATION DATA

JOB NAME/NUMBER C.C.R.R.F. TEAM LEADER WTL

SAMPLING LOCATION Unit 1 Inlet

BAROMETER CHECK

DATE	ENTROPY IN-HOUSE REFERENCE BAROMETER	FIELD BAROMETER

THERMOMETERS AND THERMOCOUPLE CHECK

DATE 8-27-91 REFERENCE THERMOMETER AMBIENT TEMPERATURE 84 °F

	AMBIENT TEMPERATURE °F	MUST BE WITHIN ACCEPTANCE RANGE °F
THERMOMETERS		
Impinger Exit	84	±2°F
Filter Compartment	85	±5.4°F
Dry Gas Meter	85	±5.4°F
Other		
THERMOCOUPLE	84	±8°F

NOTE: Adjust thermometer until acceptable. If thermometer can't be adjusted, use a backup. If no back up, then record the ambient temperature indicated by the unadjusted thermometer.

PITOT AND NOZZLE CHECK

	I.D. #	VISUAL INSPECTION CHECK
PITOTS	33	✓
	9-4	✓
	61	✓
NOZZLES	GL809	✓
	GL87	✓
	GL164	✓

ENTROPY

SAMPLING EQUIPMENT CHECKLIST

Plant Name/Address FOSTER WHEELER CAMDEN COUNTY RRF Job No. 10280

Sampling Location UNIT 1 STACK Team Leader WEM

BAROMETER CHECK

Date	Entropy In-House Reference Barometer	Field Barometer	Check OK?*
08-26-91	30.0	29.9	✓

* ± 0.1" Mercury

THERMOMETERS AND THERMOCOUPLE CHECK

Date 08-27-91 | Reference Thermometer Ambient Temperature, °F 83

	Ambient Temperature, °F	Acceptance Range, °F	Check OK?
Thermometers			
Impinger Exit	84°	± 2.0	✓
Filter Box	85°	± 5.4	✓
Dry Gas Meter	85°	± 5.4	✓

Adjust thermometer until acceptable. If it cannot be adjusted, use as back-up. If no backup, record ambient temp. indicated by unadjusted thermometer.

Thermocouple	R207 88 R230 w/ RMO-TC R229	± 8.0* (± 2.0)**	✓ ✗ WEM ✓

* ± 1.5% of Absolute Temperature.

** Acceptance range is ± 2.0°F if used in saturated or water droplet-laden gas stream.

PITOT AND NOZZLE CHECK

Pitot No.	Visual Check	Nozzle No.	Visual Check
8-9 (58)	✓	GL 699	✓
8-10 (59)	✓	GL 685	✓
8-11	✓	GL 705	✓

Dry Gas Meter Identification: 1017057 Calibration by: WLS

Date: 1-15-91 Barometric Pressure (P_b): 29.58 in. Hg

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

Approx. Flow Rate (Q) cfm	Spirometer		Dry Gas Meter		Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F					
	2.5956	77.0	2.549	70.5	-0.40	10	0.2522	~~1.0070~~ ~~1.0066~~	
	2.6047	77.0	2.526	72.0	-0.40	10	0.2531	1.0226	
	2.5592	77.0	2.462	73.0	-0.40	10	0.2487	1.0328	
	4.4080	77.0	4.339	74.0	-0.62	11	0.3894	1.0118	
	4.0619	77.0	3.973	74.0	-0.62	10	0.3947	1.0182	
	3.9799	77.0	3.953	75.0	-0.62	10	0.3867	1.0046	
	4.8178	77.0	4.800	75.0	-0.80	10	0.4681	1.0020	
	4.8634	77.0	4.770	75.0	-0.80	10	0.4726	1.0178	
	4.8634	77.0	4.794	76.0	-0.80	10	0.4726	1.0146	
	7.8142	77.0	7.711	76.0	-1.70	10	0.7693	1.0158	
	7.7596	77.0	7.693	76.0	-1.70	10	0.7540	1.0111	
	7.7140	77.0	7.684	76.0	-1.70	10	0.7496	1.0063	
	10.0000	77.0	9.979	76.0	-2.10	10	0.9717	1.0055	
	9.8725	77.0	9.850	76.0	-2.10	10	0.9593	1.0057	
	9.8178	77.0	9.845	76.0	-2.10	10	0.9540	1.0006	
	11.5392	77.0	11.591	76.0	-3.40	10	1.1212	1.0021	

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

$$Q = (17.64)\ \frac{(P_b)\ (V_s)}{(t_s + 460)\ (9)}$$

Dry Gas Meter Identification: 1017057 Calibration by: WLS

Date: 1-15-91 Barometric Pressure (P_b): 29.58 in. Hg

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

Approx. Flow Rate (Q) cfm	Spirometer		Dry Gas Meter		Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F					
	11.5118	77.0	11.592	76.0	- 3.40	10	1.1186	0.9997	
	11.5027	77.0	11.606	76.0	- 3.40	10	1.1177	0.9977	
	12.7413	77.0	12.871	76.0	- 4.40	10	1.2380	0.9990	
	12.6867	77.0	12.805	76.0	-4.40	10	1.2327	0.9999	
	12.6685	77.0	12.784	76.0	-4.40	10	1.2310	1.0001	

$\bar{Y}_{ds} = 1.0083$

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

$$Q = (17.64)\ \frac{(P_b)\ (V_s)}{(t_s + 460)\ (9)}$$

42

Dry Gas Meter Identification: 1054682 Calibration by: WLS

Date: 7-18-90 Barometric Pressure (P_b): 30.04 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

Approx. Flow Rate (Q) cfm	Spirometer		Dry Gas Meter		Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F					
	2.6230	79	2.602	80	0.51	10	0.2579	1.0089	1.0087
	2.6503	79	2.579	80	0.51	10	0.2606	1.0283	1.0283
	2.6503	79	2.563	80	0.51	10	0.2606	1.0347	1.0347
	4.0802	79	3.989	80	0.91	10	0.4011	1.0225	1.0225
	4.0528	79	3.922	80	0.91	10	0.3984	1.0330	1.0330
	4.0164	79	3.915	80	0.91	10	0.3949	1.0255	1.0255
	4.8452	79	4.696	81	1.40	10	0.4763	1.0321	1.0320
	4.8452	79	4.669	81	1.40	10	0.4763	1.0380	1.0380
	4.7996	79	4.645	81	1.40	10	0.4719	1.0336	1.0335
	7.9235	79	7.802	81	2.60	10	0.7790	1.0129	1.0129
	7.8780	79	7.880	81	2.60	10	0.7745	0.9971	0.9971
	7.9508	79	7.922	81	2.60	10	0.7817	1.0010	1.0010
	10.146	79	10.184	82	4.40	10	0.9975	0.9911	0.9911
	10.164	79	10.224	82	4.40	10	0.9993	0.9890	0.9890
	10.127	79	10.213	82	4.40	10	0.9956	0.9865	0.9865
	11.676	79	11.874	83	5.50	10	1.1479	0.9775	0.9774

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

$$Q = (17.64)\ \frac{(P_b)\ (V_s)}{(t_s + 460)\ (9)}$$

Dry Gas Meter Identification: 1054682 Calibration by: WLS

Date: 7-18-90 Barometric Pressure (P_b): 30.04 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

Approx. Flow Rate (Q) cfm	Spirometer		Dry Gas Meter		Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F					
	11.612	79	11.807	83	5.50	10	1.1416	0.9776	0.9776
	11.594	79	11.833	83	5.50	10	1.1398	0.9740	0.9739
	12.796	82	13.133	84	6.50	10	1.2510	0.9626	0.9626
	12.805	82	13.122	84	6.50	10	1.2519	0.9641	0.9641
	12.787	82	13.095	84	6.50	10	1.2502	0.9647	0.9647

$Y_{ds} \pm 1.0026$

$$Y_{ds} = \frac{(V_s)\,(t_{ds} + 460)\,(P_b)}{(V_s)\,(t_{ds} + 460)\,(P_b + (\Delta p / 13.6))}$$

$$Q = (17.64)\,\frac{(P_b)\,(V_s)}{(t_s + 460)\,(9)}$$

Dry Gas Meter Identification: 3586003 Calibration by: WLS

Date: 8-14-91 Barometric Pressure (P_b): 29.82 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

	Spirometer		Dry Gas Meter						
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q)	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	2.76	75	2.795	76	-.43	10	.23	.9904	NA
	2.75		2.765	76	-.43		.23	.9975	
	2.76		2.762	76	-.43		.23	1.0022	
	4.098		4.151	74	-.47		.55	.9865	
	4.089		4.136	74	-.47		.55	.9879	
	4.089		4.130	74	-.47		.55	.9894	
	4.927		4.985	76	-.95		.80	.9925	
	5.009		5.059	76	-.95		.80	.9943	
	4.964		5.042	76	-.95		.80	.9887	
	8.097		8.253	78	-2.2		2.10	.9920	
	8.078		8.237	78	-2.2		2.10	.9916	
	7.987		8.159	78	-2.2		2.10	.9898	
	10.383		10.636	78	-3.4		3.45	.9900	
	10.300		10.537	78	-3.4		3.45	.9913	
	10.300		10.552	78	-3.4		3.45	.9899	
	12.523		12.813	78	-4.95		4.70	.9904	

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

Dry Gas Meter Identification: 3586003 Calibration by: WLS

Date: 8-14-91 Barometric Pressure (P_b): 29.82 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

	Spirometer		Dry Gas Meter						
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q)	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	12.259	75	12.626	78	-4.95	10	4.70	.9884	NA
	12.077	↓	12.441	78	-4.95	↓	4.70	.9882	↓
	13.661		14.108	79	-5.70		5.80	.9895	
	13.652		14.107	79	-5.70		5.80	.9889	
	13.452	↓	13.925	79	-5.70	↓	5.80	.9871	↓

Y_{ds} = .9908

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

Dry Gas Meter Identification: 6838323 Calibration by: WLS

Date: 1-15-91 Barometric Pressure (P_b): 29.58 in. Hg

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

Approx. Flow Rate (Q) cfm	Spirometer Gas Volume (V_s) ft^3	Spirometer Temp. (t_s) °F	Dry Gas Meter Gas Volume (V_{ds}) ft^3	Dry Gas Meter Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	2.5956	77	2.600	72.5	- .27	10	.2522	.9906	
	2.6047	77.0	2.552	73.0	- 0.27	10	0.2531	1.0137	
	2.5592	77.0	2.506	74.0	- 0.27	10	0.2487	1.0162	
	4.4080	77.0	4.385	75.0	- 0.45	11	0.3894	1.0026	
	4.0619	77.0	4.008	76.0	- 0.45	10	0.3947	1.0127	
	3.9799	77.0	3.987	76.0	- 0.45	10	0.3867	0.9975	
	4.8178	77.0	4.831	76.0	- 0.58	10	0.4681	0.9968	
	4.8634	77.0	4.795	76.0	- 0.58	10	0.4726	1.0138	
	4.8087	77.0	4.828	77.0	- 0.58	10	0.4673	0.9974	
	7.8142	77.0	7.726	76.0	- 1.30	10	0.7593	1.0128	
	7.7596	77.0	7.716	76.0	- 1.30	10	0.7540	1.0070	
	7.7140	77.0	7.695	76.0	- 1.30	10	0.7496	1.0038	
	10.0000	77.0	9.957	76.0	- 2.00	10	0.9717	1.0075	
	9.8725	77.0	9.859	76.0	- 2.00	10	0.9593	1.0045	
	9.8178	77.0	9.844	76.0	- 2.00	10	0.9540	1.0005	
	11.5392	77.0	11.568	76.0	- 2.60	10	1.1212	1.0021	

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

$$Q = (17.64)\ \frac{(P_b)\ (V_s)}{(t_s + 460)\ (9)}$$

Dry Gas Meter Identification: 6838323 Calibration by: WLS

Date: 1-15-91 Barometric Pressure (P_b): 29.58 in. Hg

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

Approx. Flow Rate (Q) cfm	Spirometer		Dry Gas Meter		Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F					
	11.5118	77.0	11.553	76.0	-2.60	10	1.1186	1.0010	
	11.5027	77.0	11.565	76.0	-2.60	10	1.1177	0.9992	
	12.7413	77.0	12.800	76.0	-3.20	10	1.2380	1.0015	
	12.6867	77.0	12.741	76.0	-3.20	10	1.2327	1.0019	
	12.6685	77.0	12.718	76.0	-3.20	10	1.2310	1.0022	

Y_{ds} 1.0041

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

$$Q = (17.64)\ \frac{(P_b)\ (V_s)}{(t_s + 460)\ (9)}$$

ISOKINETIC METERBOX FULLTEST CALIBRATION

Meterbox No. N10 Calibrated By MBC/SWJ

Date 5-14-91 Barometric Pressure (P_b) 29.38 (In. Hg)

Date _____* Barometric Pressure (P_b) _____ (In. Hg)*

Standard Meter No. 1054682 Standard Meter Coefficient 1.0026

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H@$ In. H_2O
3.954	77	10	0.5	4.091	90	.9912	1.800
3.932			0.5	4.053	92	.9937	1.813
7.542			2.0	7.853	96	.9920	1.957
7.559			2.0	7.903	101	.9968	1.931
11.725			4.8	12.291	106	.9961	1.909
11.709	↓	↓	4.8	12.323	110	.9992	1.901
					Average	.9948	1.885

1. Coefficient range: 0.97–1.03.
2. Coefficient tolerance: for individual runs, ± 0.02 from average.
3. $\Delta H@$ range: 1.6–2.0.
4. $\Delta H@$ tolerance: ≤ 0.15 In. H_2O over ΔH range of 0.4 In.–4.0 In.

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + (\Delta H / 13.6))}$$

$$\Delta H@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

ON-SITE DRY GAS METER AUDIT

Plant Name Foster Wheeler Job Number 10280

Date 8-26-91 Meterbox Identification Number 6N-10

Time 1428 Fulltest Gamma (Y) .9948 $\Delta H_@$ 1.885

Auditor WTL Barometric Pressure (P_{bar}) 30.1 In. Hg

As Applicable:

Zero Magnehelics? (check) ✓

Zero/Level Manometer? (check) ____

Dry Gas Meter Reading (ft^3)	Meter Temperature (°F)	Upper and Lower Limits for Audit Gamma
Final 689.700	Final 100	0.96 * Y = .9550
Initial 682.332	Initial 106	1.04 * Y = 1.0345

Dry Gas Volume Metered (ft^3)	Average Meter Temperature (°F)	Run Time (Base = 10)	
		(Minutes)	(Seconds)
Vm = 7.637	Tm = 103		

$$Y_c = \frac{[\text{Min.} + (\text{Sec.} / 60)]}{Vm} * \left[\frac{0.0319\ (Tm + 460)}{P_{bar}}\right]^{0.5}$$

$$Y_c = \frac{[10 + (0 / 60)]}{7.637} * \left[\frac{0.0319\ (103 + 460)}{30.1}\right]^{0.5} = 1.0114$$

Calculated Audit Y

Audit Gamma Within Acceptable Limits? Yes ✓ No ____

ISOKINETIC METERBOX POSTTEST CALIBRATION

METERBOX NO. N10

Date 9-16-91 Calibrated By MBC/GWS Job Number 10280

Barometric Pressure (P_b) 29.69 (In. Hg) Meterbox Vacuum 16 (In. Hg)

Standard Meter No. 3586003 Standard Meter Coefficient .9908

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H@$ In. H_2O
6.422	75	10	1.4	6.625	94	.9911	1.907
6.451	↓	↓	↓	6.712	98	.9898	1.877
6.466	↓	↓	↓	6.754	100	.9894	1.861
					Average	.9901	1.882

Fulltest Y_d .9948 Date 5-14-91 % Dev. 0.5 Allowed Dev.: ± 5%

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \{\Delta H / 13.6\})}$$

$$\Delta H@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

ISOKINETIC METERBOX FULLTEST CALIBRATION

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Meterbox No. N19 Calibrated By MBC

Date 7-30-91 Barometric Pressure (P_b) 29.54 (In. Hg)

Date _____* Barometric Pressure (P_b) _____ (In. Hg)*

Standard Meter No. 6838323 Standard Meter Coefficient 1.0041

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H@$ In. H_2O
4.039	74	11	0.5	4.307	88	.9651	1.698
4.405	75	10	0.5	4.703	88	.9621	1.733
7.869	↓	10	2.0	8.295	89	.9726	1.792
7.824		10	2.0	8.265	89	.9706	1.813
12.102		10	4.8	12.637	91	.9805	1.805
13.313		11	4.8	13.917	93	.9830	1.799
					Average	.9723	1.773

1. Coefficient range: 0.97-1.03.
2. Coefficient tolerance: for individual runs, ± 0.02 from average.
3. $\Delta H@$ range: 1.6-2.0.
4. $\Delta H@$ tolerance: ≤ 0.15 In. H_2O over ΔH range of 0.4 In.-4.0 In.

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + (\Delta H / 13.6))}$$

$$\Delta H@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

ON-SITE DRY GAS METER AUDIT

Plant Name Foster Wheeler Camden County RRF Job Number 10280

Date 8-26-91 Meterbox Identification Number N-19

Time 1545 Fulltest Gamma (Y), .9723 $\Delta H_@$ 1.773

Auditor JM Barometric Pressure (P_{bar}) 30.0 In. Hg

As Applicable:

Zero Magnehelics? (check) ✓

Zero/Level Manometer? (check) ___

Dry Gas Meter Reading (ft^3)	Meter Temperature (°F)	Upper and Lower Limits for Audit Gamma
Final 506.615	Final 118	0.96 * Y = .93340
Initial 498.00	Initial 114	1.04 * Y = 1.01119

Dry Gas Volume Metered (ft^3)	Average Meter Temperature (°F)	Run Time (Base = 10)	
		(Minutes)	(Seconds)
Vm = ~~506.615~~ 8.615	Tm = ~~116~~ 116	11	0

$$Y_c = \frac{[\text{Min.} + (\text{Sec.} / 60)]}{Vm} * \left[\frac{0.0319\ (Tm + 460)}{P_{bar}}\right]^{0.5}$$

$$Y_c = \frac{[11 + (0 / 60)]}{8.615} * \left[\frac{0.0319\ (116 + 460)}{30.0}\right]^{0.5} = \underset{\text{Calculated Audit Y}}{.99927}$$

Audit Gamma Within Acceptable Limits? Yes ✓ No ___

ISOKINETIC METERBOX POSTTEST CALIBRATION

METERBOX NO. N19

Date 9-16-91 Calibrated By MBC/SW3 Job Number 10280

Barometric Pressure (P_b) 29.67 (In. Hg) Meterbox Vacuum 8.0 (In. Hg)

Standard Meter No. 1017057 Standard Meter Coefficient 1.0083

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H@$ In. H_2O
7.076	73	10	1.7	7.630	94	.9629	1.830
7.044	74	↓	↓	7.642	97	.9654	1.843
6.998	74	↓	↓	7.613	98	.9644	1.864
					Average	.9659	1.846

Fulltest Y_d .9723 Date 7-30-91 % Dev. 0.7 Allowed Dev.: ± 5%

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \{\Delta H / 13.6\})}$$

$$\Delta H@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

NOZZLE NUMBER: GL87

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
4-14-89	WLS	.268	.265	.267	.264	.266	.266

NOTE: All diameters measured in inches.

NOZZLE NUMBER: GL-164

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
10-12-9	WLS	.274	.272	.275	.274	.274	.274

NOTE: All diameters measured in inches.

ENTROPY ENVIRONMENTALISTS, INC.

NOZZLE CALIBRATION

NOZZLE NUMBER GL 695

Date	Calib. By	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
6-11-91	WLS	.271	.269	.270	.269	.271	.270

Note: 1. All diameters measured in inches.
2. Maximum 0.004 inches from lowest to highest diameter.

R-0033 rev. 3-90

ENTROPY

NOZZLE CALIBRATION

NOZZLE NUMBER GL699

Date	Calib. By	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
6-14-91	SPS	0.270	0.271	0.270	0.269	0.269	.270

Note: 1. All diameters measured in inches.
2. Maximum 0.004 inches from lowest to highest diameter.

NOZZLE CALIBRATION

NOZZLE NUMBER GL-705

Date	Calib. By	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
1-14-91	SPS	0.271	0.271	0.270	0.270	0.269	.270

Note: 1. All diameters measured in inches.
2. Maximum 0.004 inches from lowest to highest diameter.

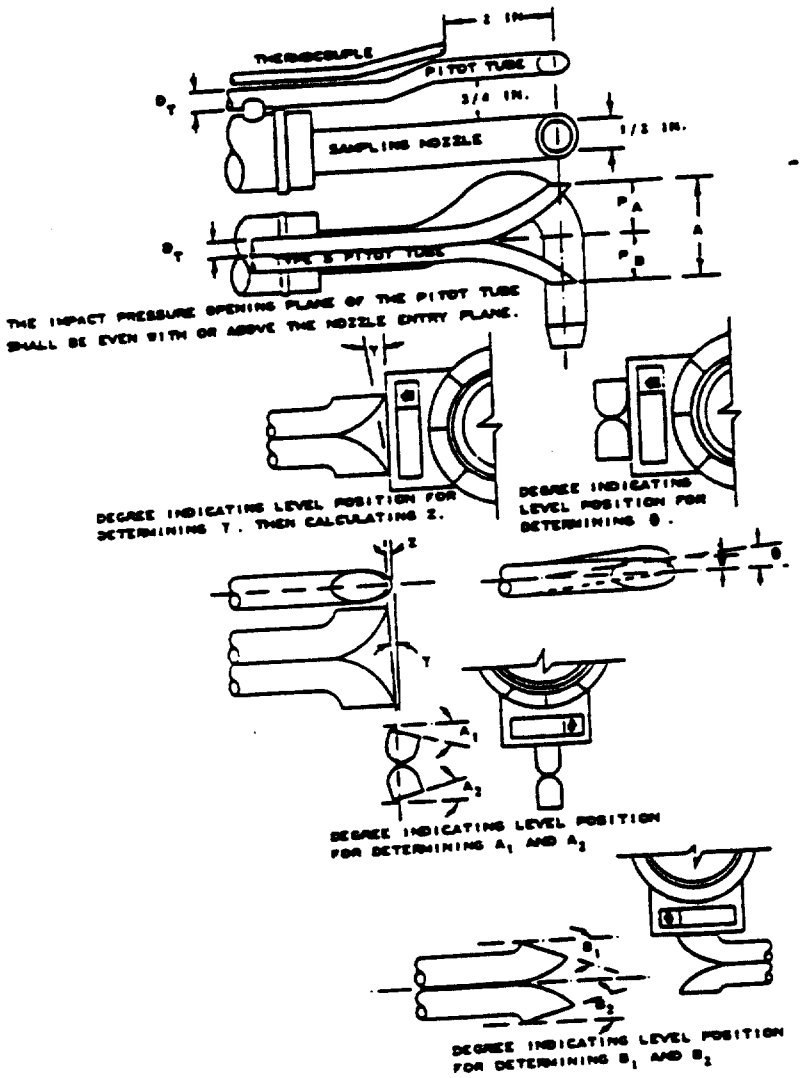
NOZZLE CALIBRATION

NOZZLE NUMBER GLP 809

Date	Calib. By	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
8-23-91	RKR	.274	.275	.275	.276	.275	.275

Note: 1. All diameters measured in inches.
2. Maximum 0.004 inches from lowest to highest diameter.

PITOT TUBE INSPECTION DATA SHEET



level?	Yes
obstructions?	None
damaged?	None
$-10^\circ < \alpha_1 < +10^\circ$	0
$-10^\circ < \alpha_2 < +10^\circ$	0
$-5^\circ < \beta_1 < +5^\circ$	0
$-5^\circ < \beta_2 < +5^\circ$	0
γ	0
θ	0
A	.917
$1.05\ D_t < P_a < 1.5\ D_t$	.461
$1.05\ D_t < P_b < 1.5\ D_t$	.456
$3/16" < D_t < 3/8"$	.375
$A \tan \gamma < 0.125"$	0
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	yes

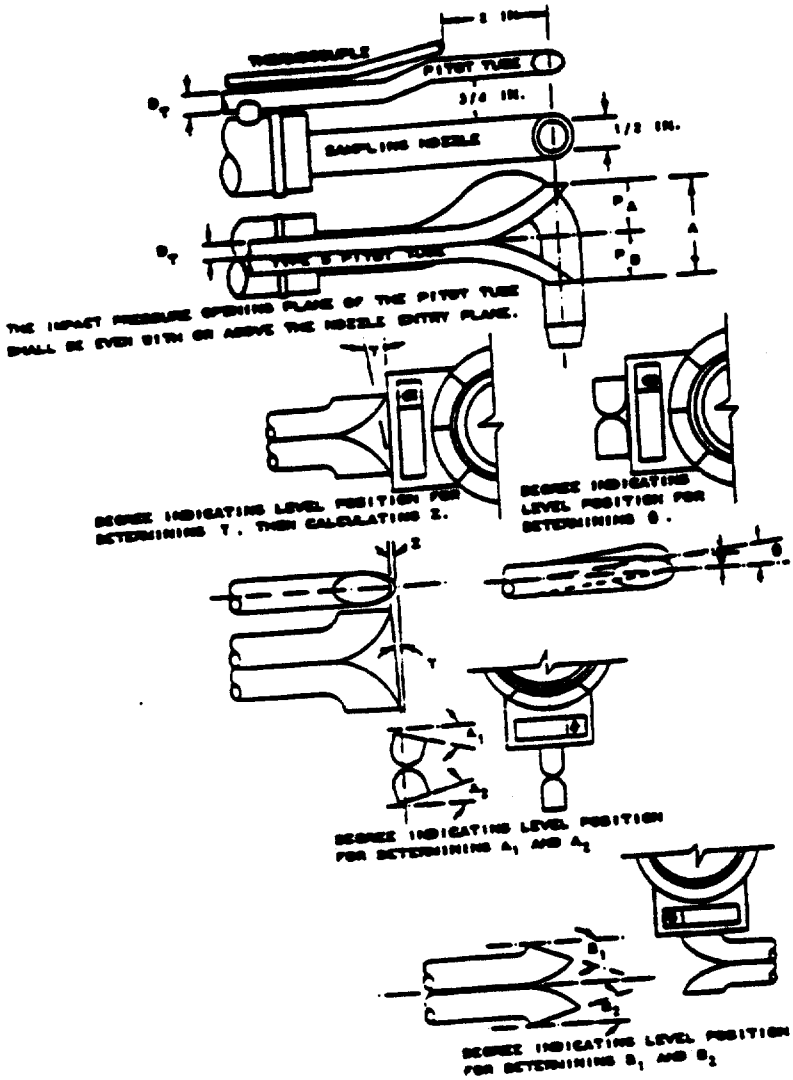
Comments: _____

I certify that pitot tube/probe number PPT-33 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

Signature W. L. Shemwell

Date 7-26-89

*SEE 40 CFR 60, VOL.42 NO. 160 METHOD 2. VERIFY THE MINIMUM 2 INCH SETBACK OF THE THERMOCOUPLE AND THE MINIMUM 3/4 INCH SEPARATION BETWEEN THE PITOT TUBE AND THE NOZZLE AS SHOWN AT THE TOP OF THIS PAGE.



level?	Yes
obstructions?	NONE
damaged?	NONE
$-10^\circ < \alpha_1 < +10^\circ$	0
$-10^\circ < \alpha_2 < +10^\circ$	0
$-5^\circ < \beta_1 < +5^\circ$	0
$-5^\circ < \beta_2 < +5^\circ$	0
γ	0
θ	0
A	.941
$1.05\ D_t < P_a < 1.5\ D_t$	.467
$1.05\ D_t < P_b < 1.5\ D_t$	.474
$3/16" < D_t < 3/8"$	.375
$A \tan \gamma < 0.125"$	0
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	Yes

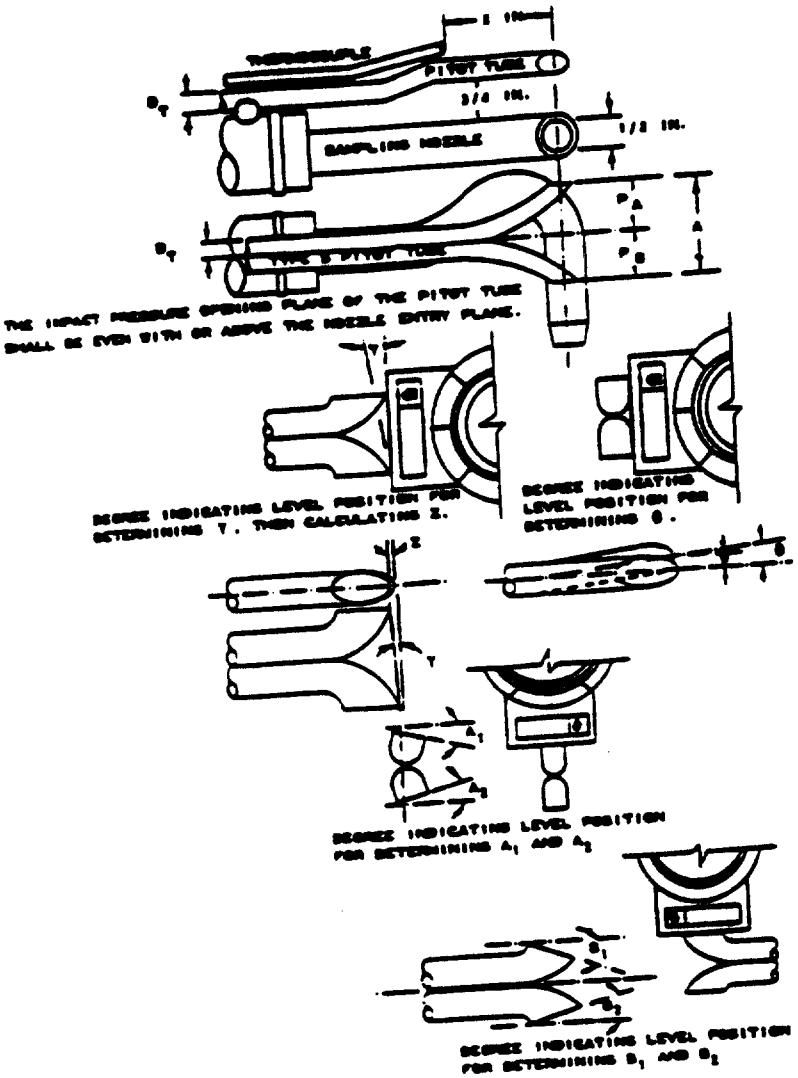
Comments: New 1-4-90

I certify that pitot tube/probe number PPT-58 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

Signature W. L. Shull

Date 1-4-90

*SEE 40 CFR 60, VOL.42 NO. 160 METHOD 2. VERIFY THE MINIMUM 2 INCH SETBACK OF THE THERMOCOUPLE AND THE MINIMUM 3/4 INCH SEPARATION BETWEEN THE PITOT TUBE AND THE NOZZLE AS SHOWN AT THE TOP OF THIS PAGE.



level?	Yes
obstructions?	None
damaged?	None
$-10^\circ < \alpha_1 < +10^\circ$	0
$-10^\circ < \alpha_2 < +10^\circ$	0
$-5^\circ < \beta_1 < +5^\circ$	0
$-5^\circ < \beta_2 < +5^\circ$	0
γ	0
θ	0
A	.940
$1.05\ D_t < P_a < 1.5\ D_t$	.468
$1.05\ D_t < P_b < 1.5\ D_t$	.472
$3/16" < D_t < 3/8"$	.375
$A \tan \gamma < 0.125"$	0
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	Yes

Comments: New 1-4-90

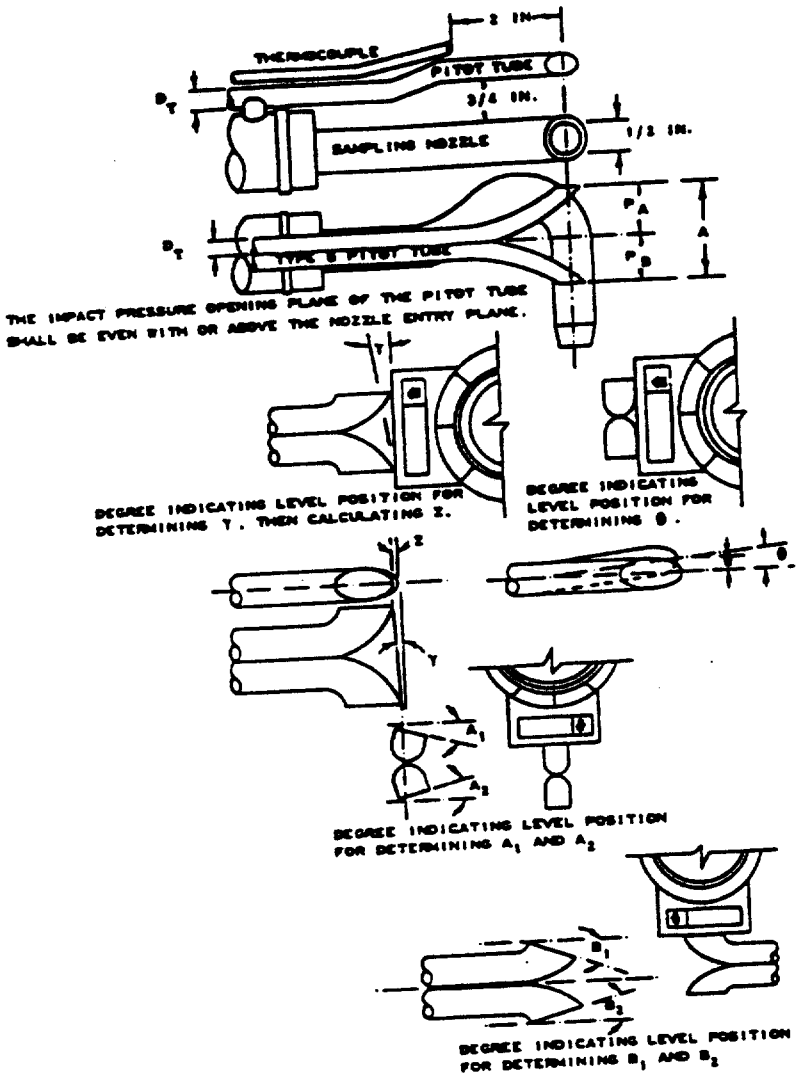
I certify that pitot tube/probe number PPT-59 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

Signature W L SHERRILL

Date 1-4-90

*SEE 40 CFR 60, VOL.42 NO. 160 METHOD 2. VERIFY THE MINIMUM 2 INCH SETBACK OF THE THERMOCOUPLE AND THE MINIMUM 3/4 INCH SEPARATION BETWEEN THE PITOT TUBE AND THE NOZZLE AS SHOWN AT THE TOP OF THIS PAGE.

PITOT TUBE INSPECTION DATA SHEET



level?	Yes
obstructions?	NONE
damaged?	NONE
$-10^\circ < \alpha_1 < +10^\circ$	0
$-10^\circ < \alpha_2 < +10^\circ$	0
$-5^\circ < \beta_1 < +5^\circ$	1°
$-5^\circ < \beta_2 < +5^\circ$	1°
γ	1°
θ	0
A	.836
$1.05\ D_t < p_a < 1.5\ D_t$	.411
$1.05\ D_t < P_b < 1.5\ D_t$	.425
$3/16" < D_t < 3/8"$	.375
$A \tan \gamma < 0.125"$	.014
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	.014

Comments: _____

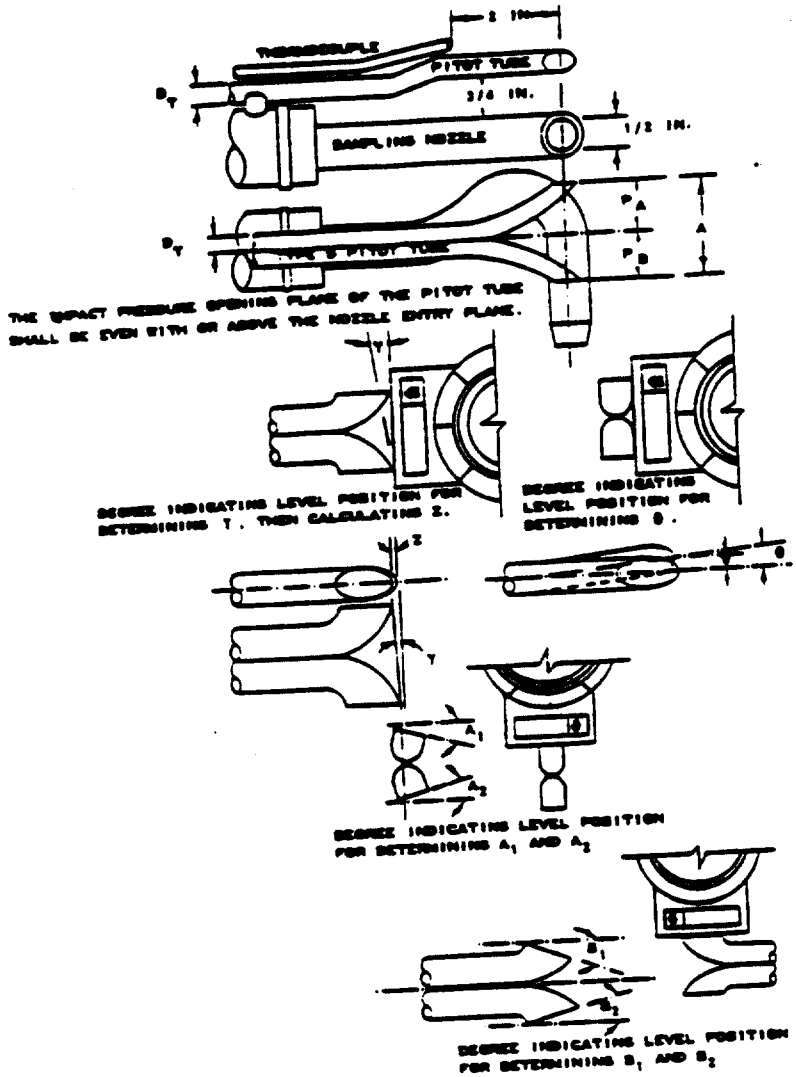
I certify that pitot tube/probe number PPT-61 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

Signature W.L. Shrum

Date 3-5-90

+SEE 40 CFR 60, VOL. 42 NO. 160 METHOD 2. VERIFY THE MINIMUM 2 INCH SETBACK OF THE THERMOCOUPLE AND THE MINIMUM 3/4 INCH SEPARATION BETWEEN THE PITOT TUBE AND THE NOZZLE AS SHOWN AT THE TOP OF THIS PAGE.

PITOT TUBE INSPECTION DATA SHEET



level?	Yes
obstructions?	None
damaged?	None
$-10^\circ < \alpha_1 < +10^\circ$	0
$-10^\circ < \alpha_2 < +10^\circ$	0
$-5^\circ < \beta_1 < +5^\circ$	0
$-5^\circ < \beta_2 < +5^\circ$	0
γ	0°
θ	0°
A	.828
$1.05\ D_t < P_a < 1.5\ D_t$	.423
$1.05\ D_t < P_b < 1.5\ D_t$	.425
$3/16" < D_t < 3/8"$	.375
$A \tan \gamma < 0.125"$	0
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	Yes

Comments: _____

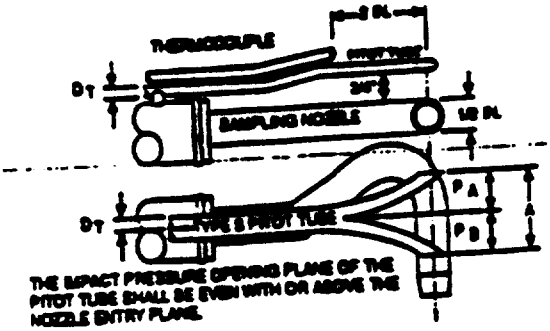
I certify that pitot tube/probe number S-4 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

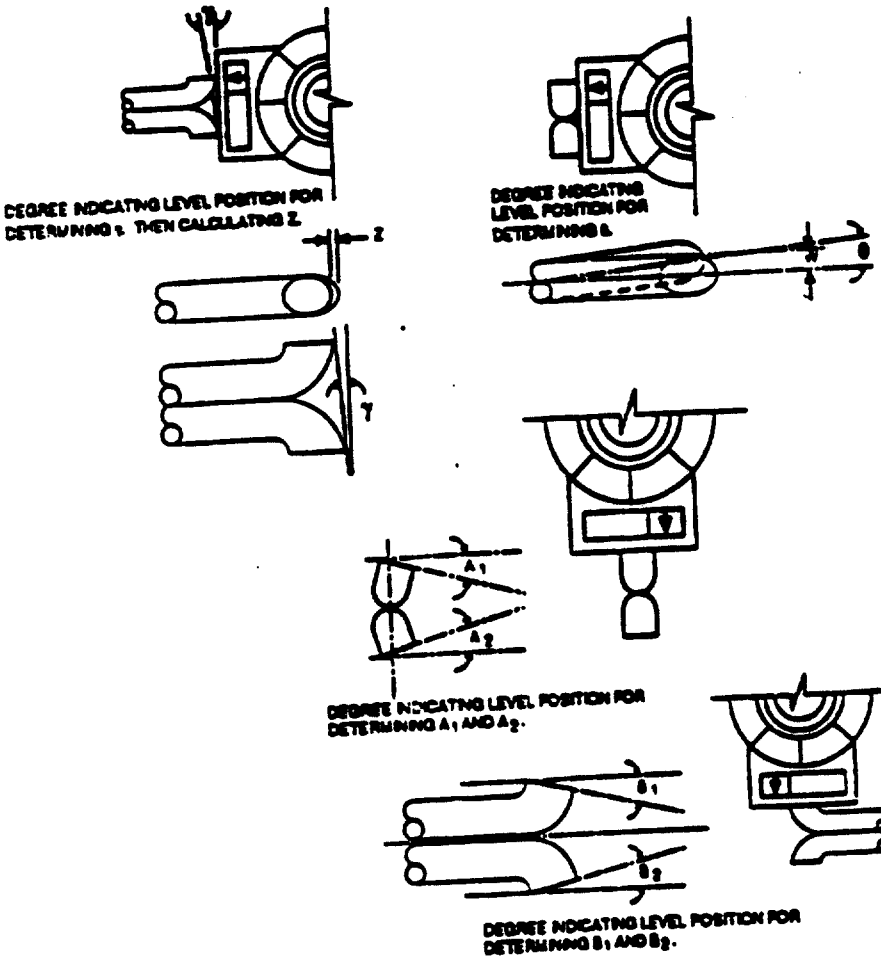
Signature W D Duvall

Date 8-2-89

+SEE 40 CFR 60, VOL.42 NO. 160 METHOD 2. VERIFY THE MINIMUM 2 INCH SETBACK OF THE THERMOCOUPLE AND THE MINIMUM 3/4 INCH SEPARATION BETWEEN THE PITOT TUBE AND THE NOZZLE AS SHOWN AT THE TOP OF THIS PAGE.

PITOT TUBE INSPECTION





level?	YES
obstructions?	NONE
damaged?	NONE
$-10° < \alpha_1 < +10°$	0
$-10° < \alpha_2 < +10°$	0
$-5° < B1 < +5°$	0
$-5° < B2 < +5°$	0
γ	0
θ	0
A	1.050
$1.05\ D_t < P_a < 1.5\ D_t$	.526
$1.05\ D_t < P_b < 1.5\ D_t$	.524
$3/16" < D_t < 3/8"$	.375
$A \tan \gamma < 0.125"$	.018
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	YES

See 40 CFR 60, Vol. 42 No. 160 EPA Method 2. Verify the minimum 2-inch setback of the thermocouple and the minimum 3/4-inch separation between the pitot tube and the nozzle as shown at the top of this page.

Comments: Nut - fixed ReBuild TO NEW

I certify that pitot tube/probe number 8-11 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Chris C Blanchard

Date 5-1-91

R-0028 rev. 3/90

THERMOCOUPLE CALIBRATION

Thermocouple No.: R127

Date: 3/10/90

Calibrated By: TAB

Barometric Pressure, Inches Hg: 29.83

Ambient Temperature, °F: 70.0

Mercury-In-Glass Thermometer I.D. No.: 7121K

Calibration System Used	Potentiometer I.D. Number	Reference Thermometer Temperature T_o °F	Reference Thermometer Temperature T_c °F	Mean Temperature of Hg Column T_m °F	Thermocouple Thermometer Temperature T_t °F	Temperature Diff., % (Allowable: ≤ 1.5 %)
Ice Bath	F23	32.0	31.96	70.0	32.0	-.01
		32.0	31.96	70.0	32.0	-.01
		32.0	31.96	70.0	33.0	-.21
Boiling Water	F23	214.0	215.82	110.0	212.0	.56
		214.0	215.82	110.0	213.0	.42
		214.0	215.82	110.0	213.0	.42
Boiling Oil	F23	390.0	398.99	120.0	390.0	1.05
		390.0	398.99	120.0	392.0	.81
		390.0	398.99	120.0	391.0	.93

$$\text{Corrected Temperature} = T_c = T_o + [(.00009) * (T_o - 20) * (T_o - T_m)]$$

$$\text{Temperature Difference} = \frac{[(T_c + 460) - (T_t + 460)]}{(T_c + 460)} * 100$$

THERMOCOUPLE CALIBRATION

Thermocouple No.: R207

Date: 8/29/90

Calibrated By: RDS/WLS

Barometric Pressure, Inches Hg: 29.40

Ambient Temperature, °F: 72.0

Mercury-In-Glass Thermometer I.D. No.: 7121K

Calibration System Used	Potentiometer I.D. Number	Reference Thermometer Temperature T_o °F	Reference Thermometer Temperature T_c °F	Mean Temperature of Hg Column T_m °F	Thermocouple Thermometer Temperature T_t °F	Temperature Diff., % (Allowable: ≤ 1.5 %)
Ice Bath	F-9	32.0	31.96	72.0	30.8	.24
		32.0	31.96	72.0	30.8	.24
		32.0	31.96	72.0	30.2	.36
Boiling Water	F-9	214.0	215.82	110.0	209.4	.95
		214.0	215.82	110.0	208.6	1.07
		214.0	215.82	110.0	208.6	1.07
Boiling Oil	F-9	388.0	396.88	120.0	385.6	1.32
		388.0	396.88	120.0	385.4	1.34
		388.0	396.88	120.0	386.4	1.22

$$\text{Corrected Temperature} = T_c = T_o + [(.00009) * (T_o - 20) * (T_o - T_m)]$$

$$\text{Temperature Difference} = \frac{[(T_c + 460) - (T_t + 460)]}{(T_c + 460)} * 100$$

THERMOCOUPLE CALIBRATION

Thermocouple No.: R238

Date: 5/17/91

Calibrated By: CCB

Barometric Pressure, Inches Hg: 29.54

Ambient Temperature, °F: 75.0

Mercury-In-Glass Thermometer I.D. No.: 7121K

Calibration System Used	Potentiometer I.D. Number	Reference Thermometer Temperature T_o °F	Reference Thermometer Temperature T_c °F	Mean Temperature of Hg Column T_m °F	Thermocouple Thermometer Temperature T_t °F	Temperature Diff., % (Allowable: ≤ 1.5 %)
Ice Bath	F32	32.0	31.97	64.0	33.0	-.21
		32.0	31.97	64.0	33.0	-.21
		32.0	31.97	64.0	33.0	-.21
Boiling Water	F32	214.0	215.82	110.0	211.0	.71
		214.0	215.82	110.0	212.0	.56
		214.0	215.82	110.0	211.0	.71
Boiling Oil	F32	390.0	398.99	120.0	388.0	1.28
		390.0	398.99	120.0	388.0	1.28
		390.0	398.99	120.0	388.0	1.28

$$\text{Corrected Temperature} = T_c = T_o + [(.00009) * (T_o - 20) * (T_o - T_m)]$$

$$\text{Temperature Difference} = \frac{[(T_c + 460) - (T_t + 460)]}{(T_c + 460)} * 100$$

THERMOCOUPLE CALIBRATION

Thermocouple No.: R239

Date: 5/17/91

Calibrated By: CCB

Barometric Pressure, Inches Hg: 29.54

Ambient Temperature, °F: 75.0

Mercury-In-Glass Thermometer I.D. No.: 7121K

Calibration System Used	Potentiometer I.D. Number	Reference Thermometer Temperature T_o °F	Reference Thermometer Temperature T_c °F	Mean Temperature of Hg Column T_m °F	Thermocouple Thermometer Temperature T_t °F	Temperature Diff., % (Allowable: ≤ 1.5 %)
Ice Bath	F32	32.0	31.96	72.0	30.6	.28
		32.0	31.96	72.0	30.6	.28
		32.0	31.96	72.0	30.6	.28
Boiling Water	F32	214.0	215.82	110.0	210.8	.74
		214.0	215.82	110.0	210.6	.77
		214.0	215.82	110.0	210.4	.80
Boiling Oil	F32	388.0	396.88	120.0	386.8	1.18
		388.0	396.88	120.0	386.6	1.20
		388.0	396.88	120.0	386.6	1.20

$$\text{Corrected Temperature} = T_c = T_o + [(.00009) * (T_o - 20) * (T_o - T_m)]$$

$$\text{Temperature Difference} = \frac{[(T_c + 460) - (T_t + 460)]}{(T_c + 460)} * 100$$

THERMOCOUPLE CALIBRATION

Thermocouple No.: R255

Date: 5/27/91

Calibrated By: WLS

Barometric Pressure, Inches Hg: 29.74

Ambient Temperature, °F: 71.0

Mercury-In-Glass Thermometer I.D. No.: 7121K

Calibration System Used	Potentiometer I.D. Number	Reference Thermometer Temperature T_o °F	Reference Thermometer Temperature T_c °F	Mean Temperature of Hg Column T_m °F	Thermocouple Thermometer Temperature T_t °F	Temperature Diff., % (Allowable: ≤ 1.5 %)
Ice Bath	F41	32.0	31.96	70.0	33.0	-.21
		32.0	31.96	70.0	32.8	-.17
		32.0	31.96	71.0	32.4	-.09
Boiling Water	F41	213.0	214.77	111.0	212.0	.41
		214.0	215.78	112.0	212.6	.47
		214.0	215.78	112.0	212.8	.44
Boiling Oil	F41	392.0	398.83	188.0	388.2	1.24
		392.0	398.83	188.0	388.1	1.25
		392.0	398.76	190.0	389.0	1.14

$$\text{Corrected Temperature} = T_c = T_o + [(.00009) * (T_o - 20) * (T_o - T_m)]$$

$$\text{Temperature Difference} = \frac{[(T_c + 460) - (T_t + 460)]}{(T_c + 460)} * 100$$

APPENDIX E

PROCESS DATA

CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES
600 MORGAN BOULEVARD, CAMDEN, NEW JERSEY 08104 - PHONE (609) 966-7174

September 30, 1991

Mr. Alan Lowe
Entropy Environmentalists, Inc.
Box 12291
Research Triangle Park, N.C.
27009-3550

Subject: Monthly Lead Testing
Boiler "A" Operational Data

Dear Mr. Lowe;

Please find enclosed a copy of the subject data. I hope the delay has not interfered with your report. Please note that this data is taken from the Bailey Net 90 Distributive Control System (DCS)for the testing date of August 27, 1991.

If there are any questions, please contact me at (609) 966-7174.

Very truly yours,

Steve Warlick
Environmental Coordinator

CC N. Wattis
B. Studley
B.Cook

DATE OF LOG 27-AUG-91 TUESDAY BOILER A SOLID WASTE PERMIT LOG PRINT TIME 00:20:44 28-AUG-91

LOG# IS TIME	HOUR MSW CHRGD MI 5175A3 Tons	DAILY MSW CHRGD MQI 5175A2 Tons	SHTR OUT FLOW FI 1078 PPH	SHTR OUT FLOW FQI 1078 KLbs	TOTAL EXPORT POWER JI 5601 MW	TOTAL EXPORT ENERGY JI 5603 MWH	TG101A OUTPUT POWER JI 6104 MW	TG101B OUTPUT POWER JI 7104 MW	TG101A OUTPUT ENERGY JI 6106 MWH	TG101B OUTPUT ENERGY JI 7106 MWH	IN HOUSE 52-F1 JI 5616 MW	IN HOUSE 52-F2 JI 5617 MW	CALC NET EXPORT JI 5600 MW
01:00	12.34	12.34	83200.00	70656.00	9.98	12304.000	4.12	9.52	7912.00	8240.000	1.88	1.68	10.14
02:00	11.88	24.22	89856.00	70656.00	10.84	12320.000	4.00	9.67	7920.00	8256.000	1.85	1.68	11.00
03:00	16.72	43.19	88448.00	70784.00	10.48	12336.000	4.97	9.20	7920.00	8256.000	1.87	1.67	10.64
04:00	9.78	50.75	85760.00	70912.00	10.55	12336.000	4.94	9.17	7928.00	8272.000	1.77	1.63	10.70
05:00	6.34	57.06	85376.00	70912.00	10.89	12352.000	6.52	8.11	7936.00	8272.000	1.75	1.64	11.05
06:00	14.67	71.73	76544.00	71040.00	9.64	12368.000	6.79	6.38	7936.00	8288.000	1.75	1.63	9.78
07:00	15.67	87.38	80000.00	71168.00	10.16	12368.000	6.66	7.04	7944.00	8288.000	1.76	1.64	10.31
08:00	16.06	103.50	87296.00	71168.00	10.83	12384.000	6.62	7.82	7952.00	8304.000	1.78	1.67	10.98
09:00	16.88	120.38	87808.00	71296.00	10.83	12400.000	6.72	7.69	7960.00	8304.000	1.77	1.66	10.98
10:00	11.44	131.75	86656.00	71424.00	11.19	12400.000	6.72	8.03	7968.00	8320.000	1.76	1.66	11.33
11:00	11.55	143.25	87552.00	71424.00	11.03	12416.000	6.79	7.80	7976.00	8320.000	1.78	1.63	11.19
12:00	7.81	151.25	86528.00	71552.00	11.36	12432.000	6.75	8.11	7976.00	8336.000	1.78	1.58	11.50
13:00	13.77	165.00	86400.00	71680.00	10.58	12432.000	6.75	7.27	7984.00	8336.000	1.72	1.58	10.72
14:00	15.44	180.44	84224.00	71680.00	11.17	12448.000	6.75	8.44	7992.00	8352.000	1.79	1.57	11.06
15:00	12.56	193.00	89088.00	71808.00	11.50	12464.000	6.75	8.28	8000.00	8352.000	1.76	1.63	11.64
16:00	17.91	210.75	83584.00	71936.00	10.91	12464.000	6.70	7.70	8008.00	8368.000	1.74	1.61	11.05
17:00	14.16	225.00	89088.00	71936.00	11.48	12480.000	6.75	8.36	8016.00	8368.000	1.94	1.54	11.64
18:00	17.03	242.00	87552.00	72064.00	10.70	12496.000	6.59	7.81	8016.00	8384.000	2.04	1.52	10.84
19:00	12.55	254.50	88960.00	72192.00	11.22	12496.000	6.58	8.34	8024.00	8384.000	2.03	1.50	11.39
20:00	18.66	273.00	87680.00	72192.00	10.77	12512.000	6.57	7.91	8032.00	8400.000	2.04	1.51	10.94
21:00	10.55	284.00	89344.00	72320.00	11.44	12528.000	6.63	8.53	8040.00	8400.000	2.04	1.52	11.61
22:00	13.09	297.00	86528.00	72448.00	10.88	12544.000	6.43	8.16	8048.00	8416.000	2.03	1.50	11.05
23:00	12.95	310.00	88832.00	72576.00	11.31	12544.000	6.55	8.50	8056.00	8416.000	2.04	1.52	11.48
24:00	15.84	325.50	86272.00	72576.00	10.69	12560.000	7.17	7.23	8056.00	8432.000	2.03	1.52	10.84
MAX	18.66		91264.00		11.67		7.17	9.67			2.04	1.67	11.83
AVG	13.57		86650.66		10.87		6.35	8.13			1.86	1.59	11.03
MIN	6.34		76544.00		9.64		4.12	6.38			1.72	1.50	9.78
SUM	325.65		2079616.		260.92		152.46	195.05			44.65	38.25	264.64

DATE OF LOG 27-AUG-91 TUESDAY BOILER A AIR PERMIT LOG Pg 1 PRINT TIME00:20:29 28-AUG-91

LOG# 11	AVG FURN TEMP	Econ Outlet Gas Temp	ATTEMP SPRAY FLOW	FEED-WATER FLOW	FEED-WATER PRESS	FEED-WATER TEMP	S H OUTLET STEAM FLOW	S H OUTLET STEAM PRESS	S H OUTLET STEAM TEMP	ECON OUTLET GAS OXYGEN	AUX FUEL GAS FLOW	LIFE-TIME MSW CHRGD	DAILY MSW CHRGD	HOUR MSW CHRGD	LIME SLRY FLOW	LIME SLRY PH
TIME	TIC 1102 DegF	TIC 1110 DegF	FI 1510 PPH	FIC 1069 PPH	PI 5030 PSIG	TI 5126 DegF	FI 1078 PPH	PI 1077 PSIG	TI 1122 DegF	AIC 1115 Pct	FIC 1136 PPH,	WQI 5175A Tons	WQI 5175A2 Tons	WQI 5175A1 Tons	FI 1305 GPM	AI 9026 pH
01:00	1154.	458.5	1650.0	88320.	1100	302.5	83200.	676.0	755.0	8.22	342.00	25836.00	12.34	12.34	8.56	6.98
02:00	1176.	455.0	2232.0	91264.	1074	302.5	89856.	678.0	756.0	8.23	342.00	25536.00	24.22	11.89	8.59	6.99
03:00	1150.	480.5	1948.0	91136.	1106	302.0	85448.	677.0	754.0	9.59	335.50	25866.00	45.19	16.72	8.58	6.98
04:00	1134.	477.0	1958.0	88064.	1102	302.0	85760.	676.0	752.0	9.72	342.50	25568.00	50.75	9.78	8.75	6.98
05:00	1190.	464.0	2820.0	84736.	1104	302.0	85376.	674.0	762.0	9.42	347.00	25568.00	57.06	6.34	9.89	6.98
06:00	1140.	458.0	2100.0	74496.	1122	302.0	76544.	670.0	755.0	8.92	344.00	25600.00	71.75	14.67	10.98	6.98
07:00	1146.	456.5	1504.0	83072.	1104	302.0	80000.	668.0	750.0	8.84	342.00	25600.00	87.38	15.67	10.64	6.98
08:00	1166.	460.5	2164.0	89344.	1096	302.0	87296.	670.0	755.0	7.95	340.50	25632.00	103.50	16.06	12.83	6.98
09:00	1174.	466.0	1740.0	93056.	1092	302.0	87808.	672.0	751.0	8.80	340.50	25632.00	120.38	16.88	10.45	6.98
10:00	1168.	465.0	1540.0	87552.	1094	302.5	86656.	674.0	753.0	7.74	345.00	25664.00	131.75	11.44	9.81	6.98
11:00	1166.	461.0	1300.0	90496.	1094	302.5	87552.	675.0	751.0	7.60	350.00	25664.00	143.25	11.55	11.98	6.98
12:00	1170.	466.0	1690.0	87936.	1092	302.5	86528.	675.0	756.0	8.77	349.50	25664.00	151.25	7.81	9.50	6.99
13:00	1164.	467.5	1758.0	87936.	1102	302.5	86400.	675.0	755.0	8.36	348.50	25696.00	165.00	13.77	8.77	7.00
14:00	1184.	466.0	1880.0	93696.	1086	302.5	91264.	678.0	755.0	7.96	348.50	25696.00	180.25	15.44	12.28	7.00
15:00	1178.	469.0	1742.0	91264.	1084	302.5	89088.	678.0	754.0	8.09	347.00	25728.00	193.00	12.86	8.73	7.01
16:00	1160.	462.0	1756.0	91008.	1086	302.5	89584.	676.0	754.0	8.42	347.00	25728.00	210.75	17.91	8.61	7.01
17:00	1182.	464.0	1788.0	92160.	1172	303.0	89088.	679.0	754.0	8.08	347.00	25760.00	225.00	14.16	8.75	7.02
18:00	1174.	473.0	1954.0	89088.	1220	304.0	87552.	678.0	755.0	8.81	344.00	25760.00	242.00	17.03	8.56	7.02
19:00	1190.	484.0	1582.0	93056.	1218	304.0	88960.	679.0	753.0	8.95	347.00	25792.00	254.50	12.55	9.25	7.02
20:00	1214.	479.5	1406.0	90496.	1220	304.0	87680.	678.0	754.0	7.98	345.50	25792.00	273.00	18.66	8.66	7.01
21:00	1218.	474.0	1102.0	93184.	1220	304.0	89344.	679.0	752.0	8.09	345.00	25824.00	284.00	10.55	8.77	7.01
22:00	1210.	475.0	900.00	91648.	1220	304.0	86528.	678.0	752.0	9.11	344.50	25824.00	297.00	13.09	13.39	7.00
23:00	1204.	477.5	746.00	93312.	1222	303.5	88832.	679.0	752.0	7.80	344.50	25824.00	310.00	12.95	9.58	7.00
24:00	1204.	468.0	687.00	91648.	1222	303.5	86272.	677.0	752.0	8.30	343.50	25856.00	325.50	15.84	8.61	7.00
MAX	1218.	484.0	2820.0	93696.	1222	304.0	91264.	679.0	762.0	9.72	350.00			18.66	13.39	7.02
AVG	1175.	467.8	1664.7	89498.	1135	302.7	86650.	675.7	753.8	8.49	344.56			13.57	9.77	6.99
MIN	1134.	455.0	687.00	74496.	1074	302.0	76544.	670.0	750.0	7.60	335.50			6.34	8.56	6.98

BOILER A AIR PERMIT LOG Pg 2

PRINT TIME 00:20:39 28-AUG-91

DATE OF LOG 27-AUG-91 TUESDAY

LOG# 12 TIME	STK OPACY AI 1190 Pct	STK NOX AI 1191 PPM	STK CO AI 1192 PPM	STK HCL AI 1193 PPM	STK SO2 AI 1194 PPM	ECOM OUT SO2 AI 1505 PPM	STK NMHC AI 1196 PPM	STK O2 AI 1198 Pct	STK H2O AI 1195 Pct	TOTAL AIR FLOW FI 1029A PPH	OFIRE AIR FLOW FI 1029B PPH	UGRATE AIR FLOW FI 1029C PPH	AUX WINBOX AIRFLO FI 1032 PPH	AIRHTR OUT TEMP TI 1033 DegF	AIRHTR INLET TEMP TI 1042 DegF
01:00	1.45	232.7	8.17	1.02	-0.81	56.69	-0.57	10.75	21.31	201216.0	58880.00	134656.0	7808.000	342.0	95.63
02:00	1.48	228.0	4.82	[illegible]	[illegible]	63.50	[illegible]	10.50	19.66	201984.0	56832.00	137216.0	7800.000	342.0	94.25
03:00	1.14	218.7	28.81	1.78	0.90	60.00	-0.58	11.33	19.19	212736.0	51200.00	153600.0	7792.000	335.5	92.13
04:00	1.14	188.0	55.38	2.70	5.05	69.75	-0.59	11.84	18.94	169216.0	32736.00	126976.0	9408.000	342.5	92.25
05:00	1.09	356.0	37.31	-0.52	19.34	59.44	-0.45	11.80	11.30	159232.0	32832.00	101632.0	24928.00	347.0	92.00
06:00	0.54	162.0	9.86	0.42	0.85	59.56	-0.56	11.30	19.09	177920.0	42112.00	121216.0	14512.00	344.0	91.13
07:00	0.39	195.7	25.22	1.44	42.50	76.63	-0.57	11.11	19.28	185856.0	48000.00	130432.0	7416.000	342.0	90.88
08:00	0.26	199.5	6.26	3.16	39.88	110.00	-0.57	10.44	21.16	197376.0	49152.00	140288.0	7808.000	340.5	93.00
09:00	0.06	195.5	9.23	1.84	5.34	155.75	-0.56	10.86	19.53	191744.0	45952.00	138240.0	7800.000	340.5	96.75
10:00	0.03	214.7	5.77	1.32	7.73	86.00	-0.15	10.31	20.78	192512.0	58304.00	126464.0	7792.000	345.0	102.00
11:00	0.11	209.2	2.17	1.89	14.20	105.00	-0.56	10.06	20.53	179712.0	63552.00	108416.0	7800.000	350.0	106.00
12:00	0.11	191.0	7.61	1.91	12.11	93.38	-0.57	10.95	18.78	185856.0	58432.00	119552.0	7800.000	349.5	108.00
13:00	0.22	205.5	9.27	1.19	4.06	77.88	-0.57	10.61	19.97	197888.0	62848.00	127232.0	7808.000	345.5	108.75
14:00	0.38	206.7	4.34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20.00	187904.0	62400.00	117888.0	7792.000	348.5	110.13
15:00	0.20	224.7	5.97	5.22	5.73	68.50	-0.56	10.44	20.31	199424.0	66304.00	125440.0	7800.000	347.0	111.63
16:00	0.24	230.0	6.48	2.33	5.52	60.25	-0.56	10.72	20.59	204288.0	67712.00	128896.0	7800.000	347.0	112.50
17:00	0.21	229.7	4.10	1.33	5.34	67.00	-0.56	10.28	19.78	195328.0	61504.00	126208.0	7800.000	347.0	112.63
18:00	0.20	226.5	7.84	0.85	3.43	58.38	-0.56	11.03	19.50	207872.0	61440.00	138752.0	7808.000	344.0	112.38
19:00	0.20	189.0	17.78	0.28	2.56	60.13	-0.56	11.17	19.47	184832.0	51456.00	125568.0	7792.000	347.0	111.75
20:00	0.21	208.7	8.39	5.86	5.06	65.00	-0.56	10.31	21.34	197376.0	59648.00	130048.0	7800.000	345.5	109.00
21:00	0.51	224.5	3.76	9.75	5.74	63.13	-0.57	10.39	20.47	200960.0	63424.00	129792.0	7800.000	345.0	106.50
22:00	0.68	117.7	29.72	265.5	93.50	108.88	-0.50	13.47	19.19	198144.0	59840.00	130560.0	7800.000	344.5	105.00
23:00	0.70	218.0	13.72	33.00	8.63	80.50	-0.58	10.17	21.06	195072.0	60096.00	127232.0	7800.000	344.5	103.50
24:00	0.61	205.0	6.48	9.03	5.14	63.00	-0.59	10.45	19.91	197632.0	57152.00	132608.0	7800.000	343.5	101.75
MAX	1.48	356.0	55.38	265.5	93.50	155.75	-0.15	13.47	21.34	212736.0	67712.00	153600.0	24928.00	350.0	112.63
AVG	0.51	211.5	13.27	17.46	13.80	77.94	-0.54	10.88	19.63	192586.6	55492.00	128288.0	8844.333	344.5	102.48
MIN	0.03	117.7	2.17	-0.52	-0.81	56.69	-0.59	10.06	11.30	159232.0	32736.00	101632.0	7416.000	335.5	90.88

DATE OF LOG 27-AUG-91 TUESDAY BUTLER A 0 JUN A1-1115 LOG PRINT TIME 00:00:53 28-AUG-91

LOG#	0001	0002	0003	0004	0005	0006	0007	0008	0009	0010	0011	0012	0013	0014	0015	0016	0017	0018	0019	0020	0021	0022	0023	00
7																								7.6
00:00	6.6	6.6	8.5	9.7	9.0	12.0	7.1	7.5	8.4	7.0	6.4	8.7	7.9	8.2	10.0	7.4	9.3	8.6	7.2	8.3	7.3	7.2	10.2	7.2
00:01	6.4	6.4	8.5	9.8	9.0	12.0	7.1	7.8	8.0	7.2	6.2	8.6	9.1	8.2	10.6	7.1	9.6	8.5	6.9	8.3	7.0	7.1	10.1	7.3
00:02	6.4	6.9	8.6	10.1	9.0	11.5	7.3	7.9	7.1	7.3	6.4	8.6	9.7	8.4	10.0	7.2	9.3	8.9	6.9	8.1	6.9	7.4	10.1	7.0
00:03	7.0	7.5	9.1	10.1	9.1	10.8	7.5	7.3	7.0	7.2	7.0	8.7	10.0	8.4	9.3	7.1	9.3	8.8	7.2	8.2	7.0	7.8	10.0	7.0
00:04	7.6	7.9	9.0	10.1	9.1	10.3	7.7	6.8	7.9	7.4	7.7	8.3	10.1	8.2	9.4	6.8	8.7	8.5	7.9	8.4	7.0	8.0	9.8	6.5
00:05	8.1	8.1	8.8	10.2	9.7	10.2	7.8	6.4	8.7	7.5	8.1	8.6	10.2	8.1	9.6	7.2	8.7	8.6	7.9	8.5	6.8	8.2	9.7	6.7
00:06	8.1	8.5	8.8	10.0	10.3	10.2	7.7	6.6	8.7	7.8	7.8	9.0	9.9	7.9	9.8	7.7	8.9	8.7	7.4	8.6	6.8	8.8	9.3	7.4
00:07	7.6	8.4	8.8	9.9	10.2	10.3	7.8	6.1	8.1	7.6	7.3	9.3	9.9	7.9	10.0	7.4	9.0	8.6	7.6	8.8	6.8	8.9	9.2	8.5
00:08	7.7	7.9	8.9	9.7	10.3	10.2	7.7	6.7	7.8	7.1	7.4	9.4	10.0	7.8	10.3	7.2	8.5	8.5	7.4	8.8	8.1	8.7	9.1	9.2
00:09	7.9	7.2	8.9	9.5	10.3	10.1	7.8	7.2	7.8	7.1	7.4	9.5	10.4	8.1	10.5	7.1	8.5	8.3	7.9	8.6	8.6	8.5	9.0	9.3
00:10	7.7	6.5	9.0	9.2	10.4	10.3	7.9	7.0	7.9	7.3	7.6	9.4	10.3	8.4	10.0	7.3	8.4	8.1	8.3	8.8	8.1	8.4	9.0	9.1
00:11	7.7	6.8	9.3	9.1	10.4	10.4	7.9	6.4	8.0	7.0	7.6	9.5	10.0	8.5	9.9	7.4	7.9	8.1	8.3	8.8	7.5	8.5	8.8	9.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.7	[illegible]	7.6	[illegible]	[illegible]	[illegible]	9.8	7.3	6.9	8.1	8.3	8.9	7.1	8.3	8.7	9.5
00:13	7.9	7.8	9.4	8.8	9.7	9.9	8.2	5.8	7.6	7.3	7.6	9.3	9.4	8.4	9.5	7.3	6.3	8.1	8.7	9.4	7.2	8.5	9.0	9.6
00:14	8.4	8.2	9.0	8.7	9.6	9.8	8.6	6.7	7.5	7.6	7.6	9.3	9.1	8.3	8.6	7.5	6.4	8.2	8.8	9.4	7.0	8.3	8.8	10.0
00:15	8.5	8.5	8.8	8.7	9.6	9.8	8.7	7.5	7.4	7.8	7.5	9.4	9.2	7.9	8.0	7.5	7.1	7.8	8.6	9.3	6.9	7.8	8.7	10.2
00:16	8.7	8.6	9.0	8.6	9.5	9.9	8.8	8.3	7.3	8.1	7.4	9.5	9.0	7.8	8.1	7.1	7.7	7.9	8.2	9.7	7.3	7.8	8.2	10.4
00:17	8.6	8.4	9.0	8.3	9.7	9.9	9.2	8.8	7.7	8.2	7.4	9.4	8.8	7.7	8.3	7.4	8.2	8.6	8.3	10.2	8.1	7.4	7.8	10.3
00:18	8.8	8.5	8.9	8.1	9.7	9.8	9.4	9.2	7.9	8.2	7.3	8.9	9.0	7.7	8.2	8.3	8.4	8.9	8.5	10.3	8.8	7.2	7.5	10.4
00:19	9.0	8.2	8.2	8.2	10.0	9.5	9.8	9.7	8.2	8.1	7.5	8.7	8.8	7.4	7.9	9.3	8.1	9.0	8.7	9.6	8.7	7.4	7.5	10.5
00:20	8.7	7.9	8.3	8.5	9.8	9.4	9.9	10.1	8.8	8.4	7.5	8.6	7.8	7.1	7.7	9.9	7.3	9.3	9.1	8.4	8.4	7.6	7.8	9.9
00:21	9.1	7.4	8.3	8.7	8.9	9.5	10.0	10.3	9.2	8.7	7.4	8.3	7.3	6.8	7.7	10.4	5.9	9.6	9.0	8.3	8.1	7.8	7.9	9.5
00:22	9.7	7.3	9.1	8.6	8.0	9.7	10.2	8.9	9.5	8.7	7.5	7.9	7.0	7.3	7.5	10.0	5.7	9.9	9.2	7.8	7.8	8.2	8.0	8.1
00:23	9.5	7.4	9.5	8.5	7.6	9.8	10.4	8.1	9.5	8.6	7.5	7.7	7.0	8.2	7.3	9.4	6.7	8.9	9.1	6.9	7.8	8.2	8.6	7.8
00:24	8.7	7.5	9.4	8.6	[illegible]	9.5	10.7	7.9	10.0	8.5	7.2	8.0	7.3	[illegible]	7.6	8.7	7.7	8.4	9.4	7.3	8.2	8.6	7.8	8.0
00:25	7.8	7.5	9.7	8.4	7.3	9.4	10.7	7.6	10.2	8.4	6.4	7.8	7.4	7.0	7.6	8.5	7.9	8.4	9.7	7.6	8.2	8.8	7.5	8.2
00:26	7.7	7.9	9.9	8.3	7.3	9.9	10.5	7.5	10.0	8.3	6.4	7.6	7.0	8.8	7.8	8.7	7.7	8.6	9.8	8.2	8.4	8.7	7.1	7.8
00:27	7.6	8.4	9.9	8.3	7.4	11.2	10.3	7.9	9.7	8.5	7.0	7.7	6.6	8.8	7.5	8.9	7.5	9.0	10.0	8.0	8.5	8.5	6.6	7.8
00:28	8.1	8.7	10.0	7.8	7.4	10.9	10.4	8.8	9.5	9.0	7.9	7.7	6.6	8.5	6.7	8.7	7.2	9.0	10.0	8.1	8.5	8.6	6.4	7.5
00:29	8.8	9.1	10.0	7.7	7.6	10.0	10.6	9.3	9.8	9.1	8.3	7.5	7.1	8.0	6.4	8.4	7.0	9.2	10.0	7.9	8.3	8.9	6.5	7.1
00:30	9.1	8.9	10.0	7.7	7.7	8.3	11.1	9.6	10.0	8.9	8.5	7.5	7.3	7.8	7.0	8.1	6.9	9.3	10.3	8.0	8.1	8.7	6.7	6.5
00:31	9.4	8.4	10.1	8.1	8.2	8.1	11.3	9.7	9.5	8.5	8.4	7.9	6.8	7.4	7.8	7.9	6.5	9.2	10.7	8.1	8.0	9.0	7.4	6.9
00:32	9.4	8.4	9.9	8.5	8.5	7.8	11.3	9.7	9.2	8.0	8.1	7.6	7.4	7.2	8.4	7.9	6.7	9.3	11.0	7.8	7.9	9.3	7.4	7.9
00:33	9.7	8.6	8.9	8.7	8.7	7.8	11.3	9.7	9.1	7.9	8.4	7.4	7.6	7.2	7.7	7.6	7.3	9.5	11.3	7.3	8.1	9.5	6.1	8.7
00:34	10.1	8.3	8.4	8.7	9.0	8.0	11.0	9.2	9.1	7.8	8.3	7.3	7.0	8.1	7.4	7.3	7.7	9.8	11.0	6.8	8.4	9.7	6.4	9.0
00:35	10.3	8.4	9.1	9.0	9.3	7.9	10.1	9.3	9.1	7.9	8.0	7.5	6.9	8.7	7.5	7.1	7.5	9.7	10.8	6.4	8.8	9.7	6.9	8.7
00:36	9.2	8.3	9.6	9.0	9.6	7.9	9.6	8.9	9.1	7.7	7.5	7.7	7.9	8.6	7.7	7.1	7.2	9.4	10.0	6.4	9.4	9.7	7.6	8.3
00:37	8.8	8.3	9.9	9.2	9.6	8.0	8.4	8.9	9.1	7.6	7.0	7.8	8.6	8.4	7.7	7.4	6.8	9.3	9.9	7.0	9.4	9.8	7.9	8.0
00:38	8.9	8.6	10.2	9.5	9.3	8.0	7.7	9.0	9.1	7.7	6.7	8.1	9.1	8.1	7.7	7.1	7.0	9.2	10.1	7.6	9.2	10.0	7.2	7.9
00:39	9.1	8.6	10.6	9.7	9.2	8.2	8.0	9.0	9.1	7.8	6.9	8.4	9.7	8.0	7.5	6.6	7.9	9.3	10.1	7.0	8.8	10.3	6.4	7.6
00:40	9.7	8.5	11.0	9.9	9.1	8.1	8.5	9.0	9.1	8.0	7.4	8.2	8.9	7.9	7.0	6.9	8.7	9.3	9.9	6.8	8.2	10.5	6.2	7.7
00:41	9.5	8.4	10.9	10.1	9.2	7.7	9.0	9.1	9.1	8.2	7.4	8.4	8.2	7.8	6.9	7.8	8.2	9.2	9.7	7.4	8.0	10.6	6.8	7.4
00:42	9.3	8.0	10.7	10.3	9.0	7.2	8.9	9.1	9.1	8.3	7.7	8.8	7.9	7.7	7.3	8.8	7.8	9.0	9.5	7.7	8.0	10.3	7.1	7.8
00:43	9.1	8.2	10.7	10.4	8.7	7.1	9.1	8.7	9.1	8.1	7.7	9.1	7.9	7.4	7.4	9.7	8.0	8.9	9.1	7.4	8.4	10.3	7.3	7.9
00:44	8.8	8.7	10.6	10.6	8.7	7.0	9.2	8.4	9.1	7.6	7.9	9.5	7.8	7.2	7.0	10.3	8.2	8.9	9.0	7.3	8.4	10.4	7.4	7.6
00:45	8.7	9.0	10.3	10.7	8.6	7.0	9.1	8.5	9.1	7.4	7.8	9.5	7.8	7.1	7.0	10.9	8.5	8.8	8.5	7.1	7.9	10.5	6.5	7.6
00:46	8.3	9.3	10.1	10.9	9.0	6.9	8.9	8.5	9.1	7.1	7.8	9.7	7.5	6.7	7.4	11.0	8.5	8.9	8.2	7.2	7.9	10.9	6.2	7.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.0	10.0	8.5	8.9	8.1	7.9	7.9	10.8	6.8	7.6
00:48	8.2	9.5	10.7	11.6	9.3	7.2	8.7	7.9	9.1	6.7	7.8	10.3	7.9	[illegible]	9.1	9.5	8.4	9.2	8.6	8.1	8.1	10.7	[illegible]	[illegible]
00:49	8.0	9.5	10.8	11.8	9.2	7.5	8.5	7.7	9.1	6.8	7.8	10.6	7.8	8.0	7.6	9.4	8.7	9.5	8.9	7.7	8.2	10.5	7.8	7.8
00:50	7.5	9.2	10.6	12.0	10.0	7.5	8.5	7.4	9.1	7.0	8.0	10.7	8.1	7.7	7.4	9.4	8.9	9.4	9.2	7.4	8.3	10.6	6.9	7.8
00:51	6.9	9.3	10.3	12.4	10.9	7.3	8.3	7.1	8.9	7.3	8.1	10.8	8.3	7.4	7.3	9.6	9.0	9.3	9.1	7.4	8.8	10.7	6.6	8.0
00:52	6.3	9.2	9.9	12.9	11.1	7.5	8.1	6.9	8.8	7.7	8.2	10.9	8.5	7.4	7.3	9.8	9.3	9.0	9.0	7.5	8.7	11.1	7.1	8.2
00:53	6.2	9.1	10.2	13.2	11.5	7.4	7.7	6.8	9.4	7.9	8.3	10.4	8.6	7.8	7.1	9.7	9.5	8.8	8.9	7.4	8.7	10.7	7.7	7.9
00:54	6.8	9.1	10.1	13.2	11.7	7.4	7.6	6.2	9.8	7.8	8.1	9.8	8.5	7.8	6.8	9.8	9.5	8.3	8.9	6.9	8.8	10.1	8.1	7.9
00:55	7.0	8.7	10.2	13.3	11.8	7.5	7.4	5.7	10.1	7.3	8.1	8.7	8.4	8.1	6.7	10.2	9.6	8.2	8.8	6.6	8.9	10.1	7.3	8.3
00:56	7.3	8.2	10.3	12.1	11.8	7.2	7.2	5.7	9.9	7.2	8.3	8.7	8.0	8.5	7.3	10.2	9.9	8.1	8.9	6.9	9.2	10.1	6.8	8.4
00:57	7.5	8.2	10.4	10.2	11.7	7.0	7.4	6.4	9.4	7.2	8.4	8.5	8.0	9.0	7.7	10.2	10.0	8.0	9.0	7.7	8.7	10.2	6.7	8.8
00:58	7.3	8.6	10.0	9.5	11.7	6.9	7.4	7.0	8.2	7.1	8.3	7.5	8.1	9.6	7.5	9.8	9.5	7.6	8.7	8.6	8.0	10.0	7.5	9.2
00:59	6.8	8.5	9.8	9.1	11.[illegible]	6.9	7.2	7.9	7.7	6.8	8.5	7.4	8.1	9.8	7.5	9.5	8.8	7.[illegible]	[illegible]	[illegible]	7.6	10.2	8.[illegible]	9.4

DATE OF LOG 27-AUG-91 TUESDAY BOILER A STACK CO AI-1192 LOG PRINT TIME 00:10:40 28-AUG-91

LOG#	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
14	2.2	0.9	18.8	31.2	18.2	16.4	4.1	9.4	2.6	13.6	2.7	3.1	13.3	6.6	4.4	0.7	16.0	5.7	7.1	9.2	2.3	6.7	33.3	1.3
00:00	2.2	1.7	18.0	27.1	3.2	17.7	4.6	9.7	2.2	10.5	3.1	3.1	11.9	5.3	5.7	1.8	14.7	6.9	6.3	8.6	2.3	7.4	34.6	1.2
00:01	1.9	2.6	15.5	24.0	0.1	18.3	4.1	10.3	2.4	7.2	2.5	3.2	10.3	4.9	8.5	2.9	14.8	8.6	5.6	8.0	4.0	7.7	34.3	2.0
00:02	1.7	2.5	12.6	22.2	0.0	17.2	3.3	9.8	3.3	5.6	2.0	4.4	9.4	4.6	12.7	3.2	15.3	10.9	4.8	7.1	5.5	7.4	33.6	2.7
00:03	1.6	1.5	10.4	21.6	0.0	13.5	3.1	7.5	4.2	4.6	1.7	5.6	8.0	4.9	15.2	3.5	14.6	13.4	3.6	6.6	6.2	7.5	33.6	3.1
00:04	1.1	0.5	8.5	22.6	0.0	8.2	3.3	5.6	5.0	4.5	0.7	5.6	7.4	6.5	16.4	3.6	14.4	13.5	2.5	6.0	6.3	7.9	30.8	3.5
00:05	0.3	0.0	7.3	27.2	0.0	4.2	3.2	5.2	5.8	4.4	0.5	5.9	8.6	7.9	17.2	3.6	13.5	12.0	1.5	5.3	6.1	7.5	28.6	3.8
00:06	0.0	0.0	7.4	31.9	0.0	2.2	3.4	5.1	6.5	3.5	1.0	5.8	10.8	8.0	17.2	3.3	11.3	11.5	1.2	5.7	6.0	7.2	28.6	3.9
00:07	[illegible]																							
00:08	[illegible]																							
00:09	0.7	0.0	9.0	31.1	0.5	0.2	2.5	5.7	8.5	4.5	1.5	6.1	13.9	7.5	15.1	1.9	8.8	8.9	3.8	3.8	4.3	5.8	22.8	3.1
00:10	2.4	0.2	11.9	28.4	1.2	0.2	2.1	5.8	6.2	5.2	2.0	6.8	14.5	6.5	14.0	2.6	7.4	8.0	3.3	4.6	3.1	5.8	21.0	2.0
00:11	3.2	1.1	12.9	26.8	1.1	0.0	1.9	3.9	4.7	6.0	1.6	7.9	15.2	5.1	14.0	3.0	6.2	8.6	3.3	5.5	3.3	6.9	20.6	2.2
00:12	2.7	1.7	13.7	29.4	1.4	0.1	1.9	3.5	4.3	6.0	1.6	8.2	16.1	4.4	13.3	3.0	5.5	9.2	3.0	6.3	4.3	7.8	20.5	4.3
00:13	3.5	1.5	15.0	30.6	1.4	1.0	2.4	3.9	4.4	6.0	1.9	6.8	16.7	4.3	12.0	3.9	4.5	9.5	3.0	6.6	5.7	8.3	20.1	5.3
00:14	4.1	1.3	14.9	34.4	1.7	1.2	2.3	3.5	4.6	5.9	1.6	6.6	16.8	4.7	11.6	5.1	4.6	9.9	3.9	6.6	6.3	7.8	20.4	6.6
00:15	5.1	0.8	15.3	42.6	1.1	2.2	2.4	3.9	4.4	6.0	1.9	6.8	16.7	4.3	12.0	3.9	4.5	9.5	3.0	6.6	5.7	7.5	21.2	9.8
00:16	6.5	0.2	14.7	46.8	1.0	2.3	2.0	1.3	7.2	4.0	1.0	15.0	16.4	5.7	10.3	3.9	1.9	6.7	4.8	10.5	2.3	46.3	26.8	20.4
00:17	6.1	0.1	13.0	43.3	0.0	1.5	2.0	0.5	7.3	3.9	1.0	17.2	15.6	6.2	10.3	2.7	1.1	6.1	4.8	10.6	2.3	46.3	26.8	20.4
00:18	6.8	0.4	12.5	36.0	0.0	1.4	2.2	0.8	6.8	4.1	1.2	17.2	15.6	6.2	10.3	2.7	1.1	6.1	4.8	10.5	2.3	46.3	26.8	20.4
00:19	8.1	1.1	13.5	29.0	0.0	1.5	2.7	1.4	6.1	3.5	1.3	18.0	15.1	5.6	7.7	1.6	0.5	5.6	4.6	13.5	0.8	55.4	30.3	19.3
00:20	8.7	2.7	15.0	24.9	0.0	1.4	3.3	1.9	5.5	3.1	1.0	15.9	13.8	5.4	5.7	1.0	0.1	4.4	5.1	17.3	0.3	56.3	31.2	19.1
00:21	9.7	4.1	16.3	24.3	0.0	1.3	4.4	2.9	5.8	4.0	0.8	12.2	12.5	5.7	5.4	0.2	0.3	3.5	5.9	18.5	0.7	57.4	27.4	20.8
00:22	10.9	4.0	16.9	24.2	0.0	1.4	6.0	4.4	7.1	4.8	1.1	7.7	11.4	4.8	5.0	1.1	1.3	4.1	6.2	16.7	1.4	58.3	22.6	19.9
00:23	11.5	3.8	16.7	23.9	0.0	1.6	7.5	6.3	7.8	5.0	0.9	4.2	11.1	4.1	3.8	4.5	2.3	5.3	6.4	14.5	2.3	58.8	20.1	16.6
00:24	11.6	4.4	16.4	25.7	0.0	2.3	9.5	8.0	7.9	5.9	0.8	3.5	11.5	3.3	3.0	7.8	2.7	6.1	7.6	14.9	2.9	59.1	19.1	12.4
00:25	11.9	4.7	14.8	22.7	0.0	3.2	14.0	8.9	9.0	6.4	1.9	3.1	10.9	1.9	2.5	9.5	2.0	6.5	8.6	17.2	3.1	58.9	18.3	9.6
00:26	12.2	4.7	12.1	17.3	0.0	3.3	22.2	7.5	11.0	6.3	2.2	2.7	7.9	0.5	2.3	9.5	0.6	6.9	9.8	16.4	2.9	58.2	17.3	8.2
00:27	11.3	5.0	10.5	16.1	0.0	3.4	33.3	5.3	13.4	7.3	1.8	3.1	5.1	0.4	2.2	8.9	0.0	5.6	11.2	13.7	3.2	58.3	16.6	6.9
00:28	9.8	4.6	12.8	16.8	0.0	11.7	43.7	3.9	15.0	7.9	1.5	2.6	4.9	1.3	2.1	8.9	0.0	4.8	12.2	12.8	3.2	58.6	15.2	4.9
00:29	9.0	3.7	14.3	18.4	0.0	47.2	46.4	3.1	13.5	9.2	0.6	1.8	5.9	2.7	2.3	9.1	0.1	5.0	14.3	11.6	3.4	58.7	12.6	3.2
00:30	9.9	3.3	14.1	19.1	0.0	93.3	40.0	2.4	11.4	10.7	0.1	2.1	6.4	4.7	2.7	8.5	0.5	5.5	17.4	10.6	3.4	59.2	8.9	3.0
00:31	11.0	2.5	17.5	17.2	0.0	79.3	40.6	2.4	11.2	10.1	0.5	2.1	5.3	6.9	3.1	8.2	1.5	6.0	17.7	10.4	3.0	59.1	5.4	4.3
00:32	12.9	2.8	23.1	14.3	0.0	40.3	66.0	3.9	13.4	9.6	0.8	1.5	3.3	8.4	2.4	8.1	1.5	6.2	19.8	11.5	3.1	26.4	3.7	5.0
00:33	14.9	5.4	27.0	12.3	0.0	20.3	124.	7.0	16.2	10.2	0.9	1.3	3.0	8.7	1.2	6.7	1.7	5.8	28.9	13.3	3.7	9.4	2.9	4.3
00:34	16.8	7.4	29.1	11.1	0.0	13.1	182.	10.1	16.2	10.2	1.4	1.4	4.6	8.0	0.8	4.7	1.2	6.4	40.8	14.6	3.5	8.2	2.5	2.7
00:35	18.0	7.8	28.3	10.5	0.0	11.2	199.	11.0	14.2	9.1	2.1	1.7	5.4	6.5	1.0	4.3	0.1	7.5	50.1	14.7	2.7	8.9	3.6	1.5
00:36	19.2	7.2	25.3	10.6	0.0	10.0	174.	11.0	13.7	7.9	3.0	1.9	6.2	3.9	1.3	4.1	0.0	7.5	55.4	13.5	2.3	9.9	3.9	2.9
00:37	23.0	6.0	21.9	11.3	2.1	8.6	114.	11.8	14.6	7.0	4.3	1.9	8.1	1.7	2.1	4.4	0.1	7.7	57.9	11.4	2.3	9.9	2.3	5.6
00:38	27.4	5.6	19.4	11.7	34.4	6.9	62.3	11.5	15.8	6.3	6.1	3.5	7.3	1.4	1.6	4.0	0.6	8.5	54.2	8.5	2.8	10.1	1.4	5.5
00:39	29.0	6.6	19.9	11.6	140.	6.6	31.7	9.5	16.0	6.1	7.7	6.0	3.5	2.2	2.2	2.8	1.1	8.7	52.4	5.7	3.9	14.4	0.7	5.1
00:40	24.4	7.6	26.8	11.5	258.	7.8	18.4	7.7	13.5	6.0	8.4	6.7	1.8	3.3	4.6	2.5	1.2	8.3	55.0	4.3	4.4	15.0	1.9	5.0
00:41	17.5	7.9	44.1	11.5	259.	8.1	13.4	6.9	9.8	5.3	7.5	6.5	1.9	3.3	6.4	2.9	0.6	8.7	58.6	4.3	4.0	19.6	4.2	5.4
00:42	12.4	7.9	62.9	13.6	258.	7.5	11.4	6.7	8.5	4.8	4.9	6.2	3.8	2.9	6.7	2.7	0.4	8.6	57.7	4.5	4.1	26.8	4.1	5.9
00:43	10.0	[illegible]					11.3	6.	10.	5.4	2.5	4.2	[illegible]	[illegible]	5.4	2.2	[illegible]	7.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
00:44	9.1	6.5	70.4	24.1	619.	5.9	11.6	7.0	11.3	5.9	1.9	3.5	9.0	2.7	3.0	2.3	2.1	6.4	43.3	2.4	3.5	26.8	1.4	5.7
00:45	7.8	6.9	72.8	31.6	220.	5.4	11.4	6.3	8.5	6.5	1.1	4.6	9.3	2.2	1.7	3.4	2.9	6.0	34.8	2.6	4.0	28.1	1.2	5.8
00:46	6.7	6.8	80.5	42.6	2.3	5.4	11.0	6.4	6.4	6.3	0.8	5.8	9.3	1.6	1.9	6.0	2.9	5.7	29.2	4.1	2.7	31.9	0.9	6.3
00:47	6.9	6.3	84.0	45.8	0.0	5.4	11.5	7.8	6.6	6.2	1.3	7.5	8.9	0.8	1.9	10.5	2.5	6.0	26.1	5.2	2.1	37.4	1.1	7.1
00:48	6.7	6.8	75.5	44.4	0.0	5.1	11.4	8.9	8.6	6.6	1.2	9.3	7.8	0.4	0.9	15.4	2.3	7.0	25.8	5.1	2.4	45.6	1.4	7.1
00:49	6.4	6.8	76.5	44.4	0.0	5.2	11.4	9.2	9.8	6.6	1.1	10.4	6.9	0.6	0.1	17.5	2.1	7.8	23.3	4.2	2.6	50.4	1.0	5.9
00:50	6.4	7.6	60.0	55.4	0.0	5.0	12.4	8.7	10.0	4.8	2.1	11.5	6.8	0.7	0.2	17.2	1.7	9.2	17.4	3.1	3.2	49.9	0.3	4.4
00:51	6.4	8.7	57.1	85.3	0.0	4.5	12.3	8.1	9.3	2.9	2.9	13.7	6.9	0.6	1.2	16.2	2.3	9.4	12.6	3.2	3.9	48.4	0.3	4.7
00:52	5.3	9.3	65.3	119.	0.0	5.5	12.1	7.5	9.0	1.8	3.2	16.1	6.8	1.2	3.4	16.2	2.8	10.5	9.8	4.0	4.2	48.1	0.6	5.6
00:53	4.0	8.3	63.9	148.	0.1	6.0	12.1	7.6	10.4	1.2	3.3	17.5	7.0	2.9	4.5	18.0	2.6	11.8	8.3	4.4	4.4	49.5	1.0	4.6
00:54	3.1	8.3	52.6	184.	1.0	6.0	10.5	6.8	11.8	0.8	3.3	17.8	7.2	5.5	4.2	17.1	2.7	11.2	7.7	4.7	4.6	58.7	0.9	3.9
00:55	3.4	10.3	43.6	241.	6.1	5.0	9.9	6.2	13.3	0.9	3.2	18.2	6.8	7.1	4.0	15.2	2.8	10.1	7.8	5.6	5.0	59.9	0.3	3.8
00:56	3.8	11.6	40.4	304.	14.4	4.5	11.3	6.1	15.0	1.2	3.1	20.1	7.0	6.1	3.8	13.9	2.5	9.3	8.1	6.2	5.7	43.6	0.2	3.3
00:57	3.1	12.1	39.2	346.	21.9	3.9	11.5	5.5	15.6	1.3	3.1	20.2	7.4	4.8	3.0	12.9	2.9	8.4	10.0	6.2	6.5	31.4	1.4	2.9
00:58	1.7	13.6	37.1	350.	24.5	2.8	10.5	4.3	15.3	1.5	3.0	17.9	7.4	4.4	2.1	13.7	3.8	7.7	11.3	5.6	7.1	30.8	2.1	2.5
00:59	0.9	15.3	35.6	233.	22.3	2.9	9.5	3.2	15.2	1.9	2.8	15.1	7.6	4.4	0.6	15.8	4.6	7.7	[illegible]	4.1	6.9	32.8	1.7	2.1
00:59	0.7	17.2	34.6	85.6	17.-	3.5																		

APPENDIX F

SAMPLING AND ANALYTICAL PROCEDURES

METHOD 1—SAMPLE AND VELOCITY TRAVERSES FOR STATIONARY SOURCES

1. *Principle and Applicability*

1.1 Principle. To aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source, a measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. A traverse point is then located within each of these equal areas.

1.2 Applicability. This method is applicable to flowing gas streams in ducts, stacks, and flues. The method cannot be used when: (1) flow is cyclonic or swirling (see Section 2.4), (2) a stack is smaller than about 0.30 meter (12 in.) in diameter, or 0.071 m^2 (113 $in.^2$) cross-sectional area, or (3) the measurement site is less than two stack or duct diameters downstream or less than a half diameter upstream from a flow disturbance.

The requirements of this method must be considered before construction of a new facility from which emissions will be measured; failure to do so may require subsequent alterations to the stack or deviation from the standard procedure. Cases involving variants are subject to approval by the Administrator, U.S. Environmental Protection Agency.

2. *Procedure*

2.1 Selection of Measurement Site. Sampling or velocity measurement is performed at a site located at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, or contraction in the stack, or from a visible flame. If necessary, an alternative location may be selected, at a position at least two stack or duct diameters downstream and a half diameter upstream from any flow disturbance. For a rectangular cross section, an equivalent diameter (D_e) shall be calculated from the following equation, to determine the upstream and downstream distances:

$$D_e = \frac{2LW}{(L+W)}$$

where L = length and W = width.

An alternative procedure is available for determining the acceptability of a measurement location not meeting the criteria above. This procedure, determination of gas flow angles at the sampling points and comparing the results with acceptability criteria, is described in Section 2.5.

2.2 Determining the Number of Traverse Points.

2.2.1 Particulate Traverses. When the eight- and two-diameter criterion can be met, the minimum number of traverse points shall be: (1) twelve, for circular or rectangular stacks with diameters (or equivalent diameters) greater than 0.61 meter (24 in.); (2) eight, for circular stacks with diameters between 0.30 and 0.61 meter (12-24 in.); (3) nine, for rectangular stacks with equivalent diameters between 0.30 and 0.61 meter (12-24 in.).

When the eight- and two-diameter criterion cannot be met, the minimum number of traverse points is determined from Figure 1-1. Before referring to the figure, however, determine the distances from the chosen measurement site to the nearest upstream and downstream disturbances, and divide each distance by the stack diameter or equivalent diameter, to determine the distance in terms of the number of duct diameters. Then, determine from Figure 1-1 the minimum number of traverse points that corresponds: (1) to the number of duct diameters upstream; and (2) to the number of diameters downstream. Select the higher of the two minimum numbers of traverse points, or a greater value, so that for circular stacks the number is a multiple of 4, and for rectangular stacks, the number is one of those shown in Table 1-1.

TABLE 1-1. CROSS-SECTION LAYOUT FOR RECTANGULAR STACKS

Number of traverse points	Matrix layout
9	3x3
12	4x3
16	4x4
20	5x4
25	5x5
30	6x5
36	6x6
42	7x6
49	7x7

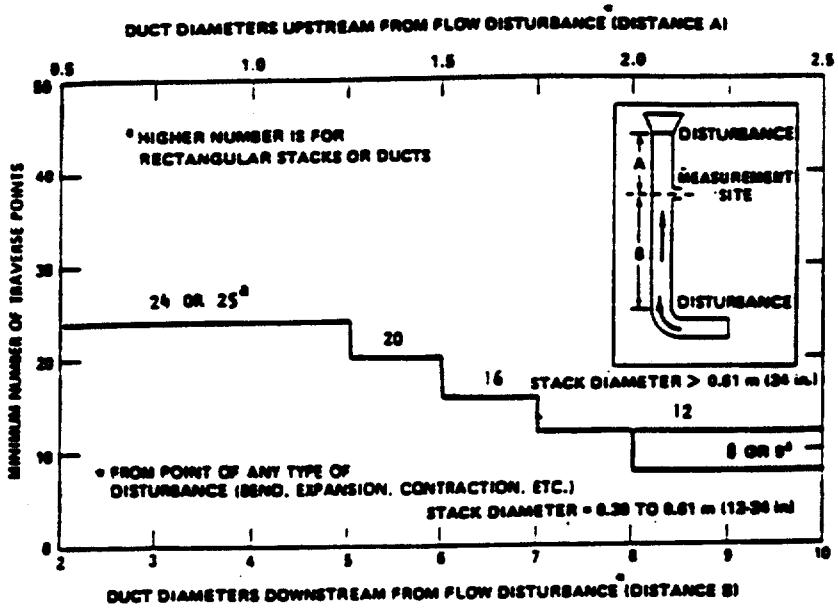


Figure 1-1. Minimum number of traverse points for particulate traverses.

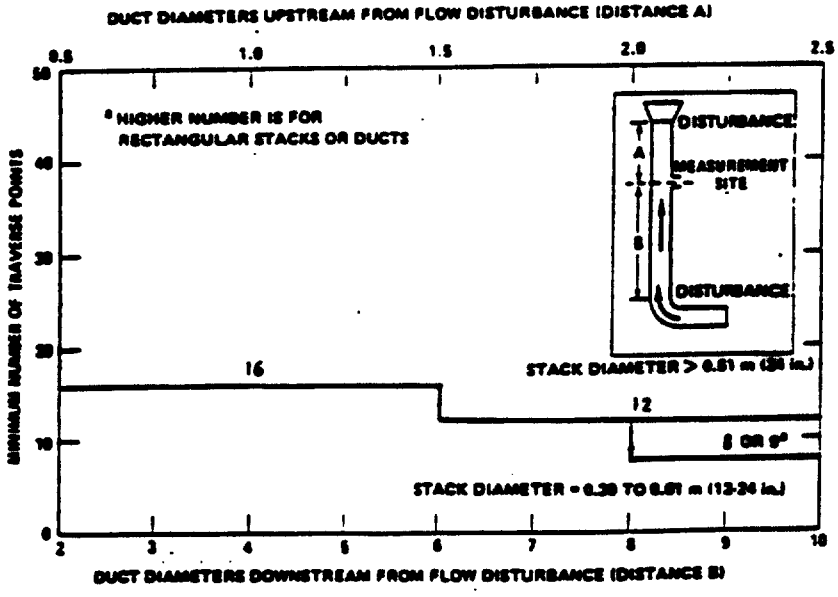


Figure 1-2. Minimum number of traverse points for velocity (nonparticulate) traverses.

2.3.1.2 Stacks With Diameters Equal to or Less Than 0.61 m (24 in.). Follow the procedure in Section 2.3.1.1, noting only that any "adjusted" points should be relocated away from the stack walls to: (1) a distance of 1.3 cm (0.50 in.); or (2) a distance equal to the nozzle inside diameter, whichever is larger.

2.3.2 Rectangular Stacks. Determine the number of traverse points as explained in Sections 2.1 and 2.2 of this method. From Table 1-1, determine the grid configuration. Divide the stack cross-section into as many equal rectangular elemental areas as traverse points, and then locate a traverse point at the centroid of each equal area according to the example in Figure 1-4.

If the tester desires to use more than the minimum number of traverse points, expand the "minimum number of traverse points" matrix (see Table 1-1) by adding the extra traverse points along one or the other or both legs of the matrix; the final matrix need not be balanced. For example, if a 4x3 "minimum number of points" matrix were expanded to 36 points, the final matrix could be 9x4 or 12x3, and would not necessarily have to be 6x6. After constructing the final matrix, divide the stack cross-section into as many equal rectangular, elemental areas as traverse points, and locate a traverse point at the centroid of each equal area.

The situation of traverse points being too close to the stack walls is not expected to arise with rectangular stacks. If this problem should ever arise, the Administrator must be contacted for resolution of the matter.

2.4 Verification of Absence of Cyclonic Flow. In most stationary sources, the direction of stack gas flow is essentially parallel to the stack walls. However, cyclonic flow may exist (1) after such devices as cyclones and inertial demisters following venturi scrubbers, or (2) in stacks having tangential inlets or other duct configurations which tend to induce swirling; in these instances, the presence or absence of cyclonic flow at the sampling location must be determined. The following techniques are acceptable for this determination.

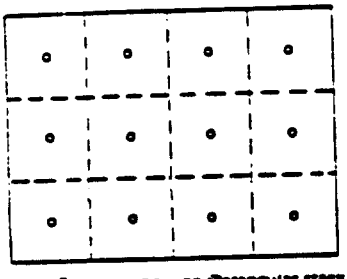


Figure 1-4. Example showing rectangular stack cross section divided into 12 equal areas, with a traverse point at centroid of each area.

Level and zero the manometer. Connect a Type S pitot tube to the manometer. Position the Type S pitot tube at each traverse point, in succession, so that the planes of the face openings of the pitot tube are perpendicular to the stack cross-sectional plane; when the Type S pitot tube is in this position, it is at "0° reference." Note the differential pressure (Δp) reading at each traverse point. If a null (zero) pitot reading is obtained at 0° reference at a given traverse point, an acceptable flow condition exists at that point. If the pitot reading is not zero at 0° reference, rotate the pitot tube (up to ±90° yaw angle), until a null reading is obtained. Carefully determine and record the value of the rotation angle (α) to the nearest degree. After the null technique has been applied at each traverse point, calculate the average of the absolute values of α; assign α values of 0° to those points for which no rotation was required, and include these in the overall average. If the average value of α is greater than 20°, the overall flow condition in the stack is unacceptable and alternative methodology, subject to the approval of the Administrator, must be used to perform accurate sample and velocity traverses.

The alternative procedure described in Section 2.5 may be used to determine the rotation angles in lieu of the procedure described above. The limit of acceptability for the average value of α would remain 20°.

2.5 Alternative Measurement Site Selection Procedure. This alternative applies to sources where measurement locations are less than 2 equivalent stack or duct diameters downstream or less than ½ duct diameter upstream from a flow disturbance. The alternative should be limited to ducts larger than 24 in. in diameter where blockage and wall effects are minimal. A directional flow-sensing probe is used to measure pitch and yaw angles of the gas flow at 40 or more traverse points; the resultant angle is calculated and compared with acceptable criteria for mean and standard deviation.

Note.—Both the pitch and yaw angles are measured from a line passing through the traverse point and parallel to the stack axis. The pitch angle is the angle of the gas flow component in the plane that INCLUDES the traverse line and is parallel to the stack axis. The yaw angle is the angle of the gas flow component in the plane PERPENDICULAR to the traverse line at the traverse point and is measured from the line passing through the traverse point and parallel to the stack axis.

2.5.1 Apparatus.

2.5.1.1 Directional Probe. Any directional probe, such as United Sensor Type DA Three-Dimensional Directional Probe, capable of measuring both the pitch and yaw angles of gas flows is acceptable. (Note: Mention of trade name or specific products does not constitute endorsement by the U.S. Environmental Protection Agency.) Assign an identification number to the directional probe, and permanently mark or engrave the number on the body of the probe. The pressure holes of directional probes are susceptible to plugging when used in particulate-laden gas streams. Therefore, a system for cleaning the pressure holes by "back-purging" with pressurized air is required.

2.5.1.2 Differential Pressure Gauges. Inclined manometers, U-tube manometers, or other differential pressure gauges (e.g., magnehelic gauges) that meet the specifications described in Method 2, § 2.2.

Note.—If the differential pressure gauge produces both negative and positive readings, then both negative and positive pressure readings shall be calibrated at a minimum of three points as specified in Method 2, § 2.2.

2.5.2 Traverse Points. Use a minimum of 40 traverse points for circular ducts and 42 points for rectangular ducts for the gas flow angle determinations. Follow § 2.3 and Table 1-1 or 1-2 for the location and layout of the traverse points. If the measurement location is determined to be acceptable according to the criteria in this alternative procedure, use the same traverse point number and locations for sampling and velocity measurements.

2.5.3 Measurement Procedure.

2.5.3.1 Prepare the directional probe and differential pressure gauges as recommended by the manufacturer. Capillary tubing or surge tanks may be used to dampen pressure fluctuations. It is recommended, but not required, that a pretest leak check be conducted. To perform a leak check, pressurize or use suction on the impact opening until a reading of at least 7.6 cm (3 in.) H_2O registers on the differential pressure gauge, then plug the impact opening. The pressure of a leak-free system will remain stable for at least 15 seconds.

2.5.3.2 Level and zero the manometers. Since the manometer level and zero may drift because of vibrations and temperature changes, periodically check the level and zero during the traverse.

2.5.3.3 Position the probe at the appropriate locations in the gas stream, and rotate until zero deflection is indicated for the yaw angle pressure gauge. Determine and record the yaw angle. Record the pressure gauge readings for the pitch angle, and determine the pitch angle from the calibration curve. Repeat this procedure for each traverse point. Complete a "back-purge" of the pressure lines and the impact openings prior to measurements of each traverse point.

A post-test check as described in § 2.5.3.1 is required. If the criteria for a leak-free system are not met, repair the equipment, and repeat the flow angle measurements.

2.5.4 Calculate the resultant angle at each traverse point, the average resultant angle, and the standard deviation using the following equations. Complete the calculations retaining at least one extra significant figure beyond that of the acquired data. Round the values after the final calculations.

15. Smith, Marvin L. Velocity Calibration of EPA Type Source Sampling Probe. United Technologies Corporation. Pratt and Whitney Aircraft Division. East Hartford. Conn. 1975.

16. Vollaro, R. F. Recommended Procedure for Sample Traverses in Ducts Smaller than 12 Inches in Diameter. U.S. Environmental Protection Agency. Emission Measurement Branch. Research Triangle Park N.C. November 1976.

17. Ower, E. and R. C. Pankhurst. The Measurement of Air Flow. 4th Ed., London. Pergamon Press. 1966.

18. Vollaro, R. F. A Survey of Commercially Available Instrumentation for the Measurement of Low-Range Gas Velocities. U.S. Environmental Protection Agency. Emission Measurement Branch. Research Triangle Park N.C. November 1976. (Unpublished Paper)

19. Gnyp, A. W., C. C. St. Pierre, D. S. Smith, D. Mesmon, and J. Steiner. An Experimental Investigation of the Effect of Pitot Tube-Sampling Probe Configurations on the Magnitude of the S Type Pitot Tube Coefficient for Commercially Available Source Sampling Probes. Prepared by the University of Windsor for the Ministry of the Environment, Toronto, Canada. February 1975.

METHOD 2—DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (TYPE S PITOT TUBE)

1. *Principle and Applicability*

1.1 Principle. The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type S (Stausscheibe or reverse type) pitot tube.

1.2 Applicability. This method is applicable for measurement of the average velocity of a gas stream and for quantifying gas flow.

This procedure is not applicable at measurement sites which fail to meet the criteria of Method 1, Section 2.1. Also, the method cannot be used for direct measurement in cyclonic or swirling gas streams; Section 2.4 of Method 1 shows how to determine cyclonic or swirling flow conditions. When unacceptable conditions exist, alternative procedures, subject to the approval of the Administrator, U.S. Environmental Protection Agency, must be employed to make accurate flow rate determinations; examples of such alternative procedures are: (1) to install straightening vanes; (2) to calculate the total volumetric flow rate stoichiometrically, or (3) to move to another measurement site at which the flow is acceptable.

2. *Apparatus*

Specifications for the apparatus are given below. Any other apparatus that has been demonstrated (subject to approval of the Administrator) to be capable of meeting the specifications will be considered acceptable.

2.1 Type S Pitot Tube. The Type S pitot tube (Figure 2-1) shall be made of metal tubing (e.g. stainless steel). It is recommended that the external tubing diameter (dimension D_t, Figure 2-2b) be between 0.48 and 0.95 centimeters (3/16 and 3/8 inch). There shall be an equal distance from the base of each leg of the pitot tube to its face-opening plane (dimensions P_A and P_B, Figure 2-2b); it is recommended that this distance be between 1.05 and 1.50 times the external tubing diameter. The face openings of the pitot tube shall, preferably, be aligned as shown in Figure 2-2; however, slight misalignments of the openings are permissible (see Figure 2-3).

The Type S pitot tube shall have a known coefficient, determined as outlined in Section 4. An identification number shall be assigned to the pitot tube; this number shall be permanently marked or engraved on the body of the tube.

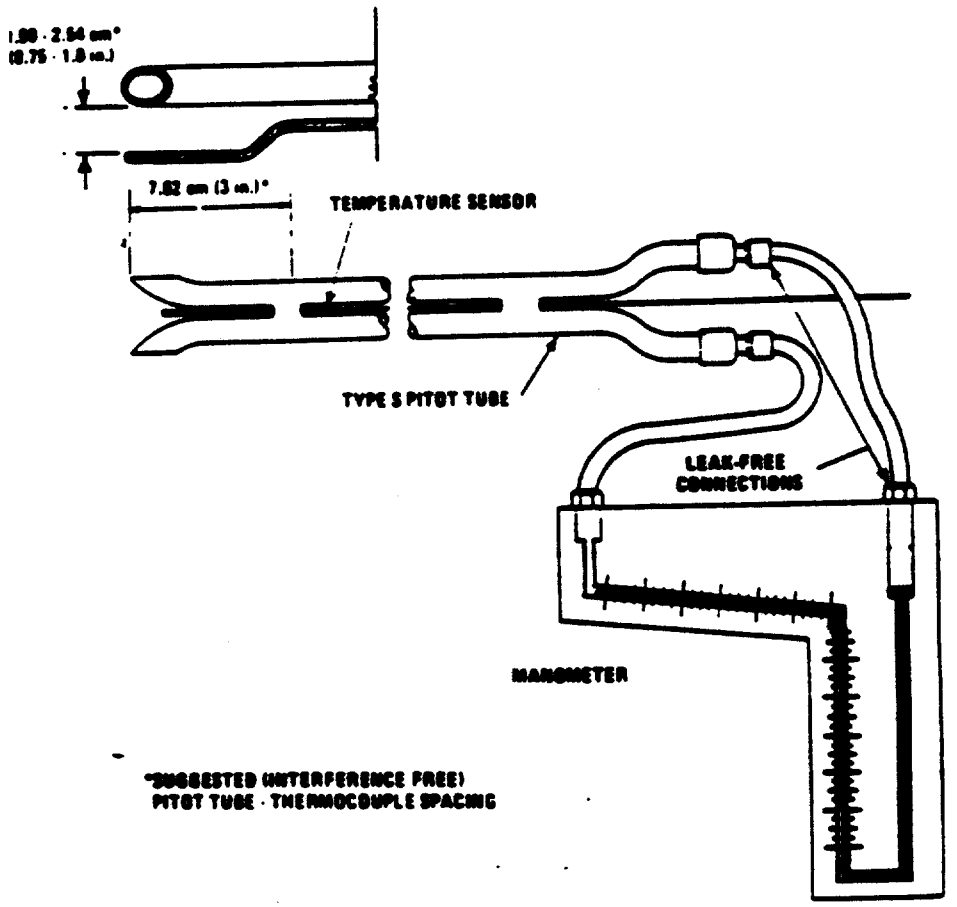


Figure 2-1. Type S pitot tube manometer assembly.

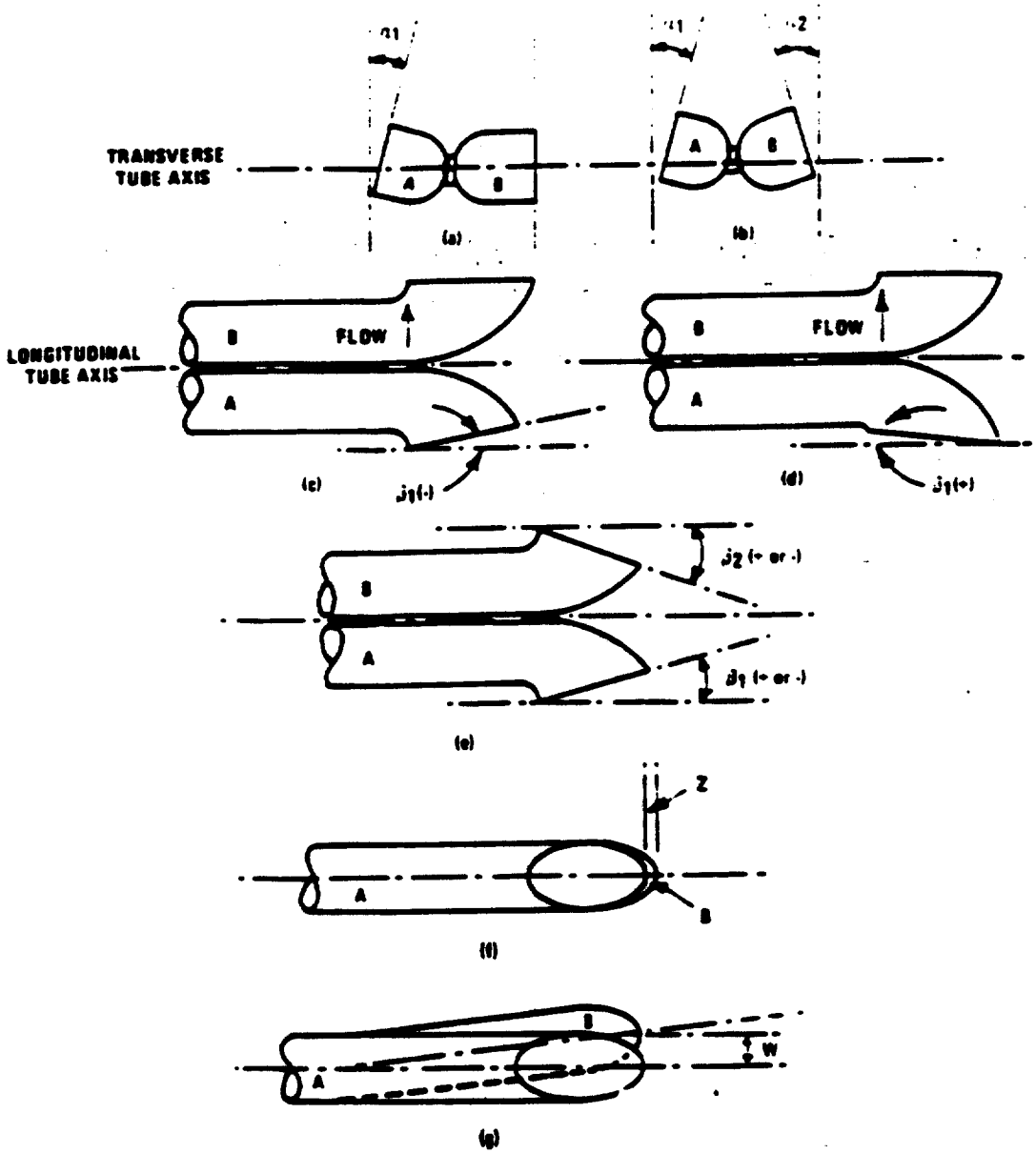


Figure 2-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of Cp(s) so long as $\alpha 1$ and $\alpha 2$ 10°, $\beta 1$ and $\beta 2$ 5°, z 0.32 cm (1/8 in.) and w 0.08 cm (1/32 in.) (citation 11 in Section 6).

A standard pitot tube may be used instead of a Type S, provided that it meets the specifications of Sections 2.7 and 4.2; note, however, that the static and impact pressure holes of standard pitot tubes are susceptible to plugging in particulate-laden gas streams. Therefore, whenever a standard pitot tube is used to perform a traverse, adequate proof must be furnished that the openings of the pitot tube have not plugged up during the traverse period; this can be done by taking a velocity head (Δp) reading at the final traverse point, cleaning out the impact and static holes of the standard pitot tube by "back-purging" with pressurized air, and then taking another Δp reading. If the Δp readings made before and after the air purge are the same (±5 percent), the traverse is acceptable. Otherwise, reject the run. Note that if Δp at the final traverse point is unsuitably low, another point may be selected. If "back-purging" at regular intervals is part of the procedure, then comparative Δp readings shall be

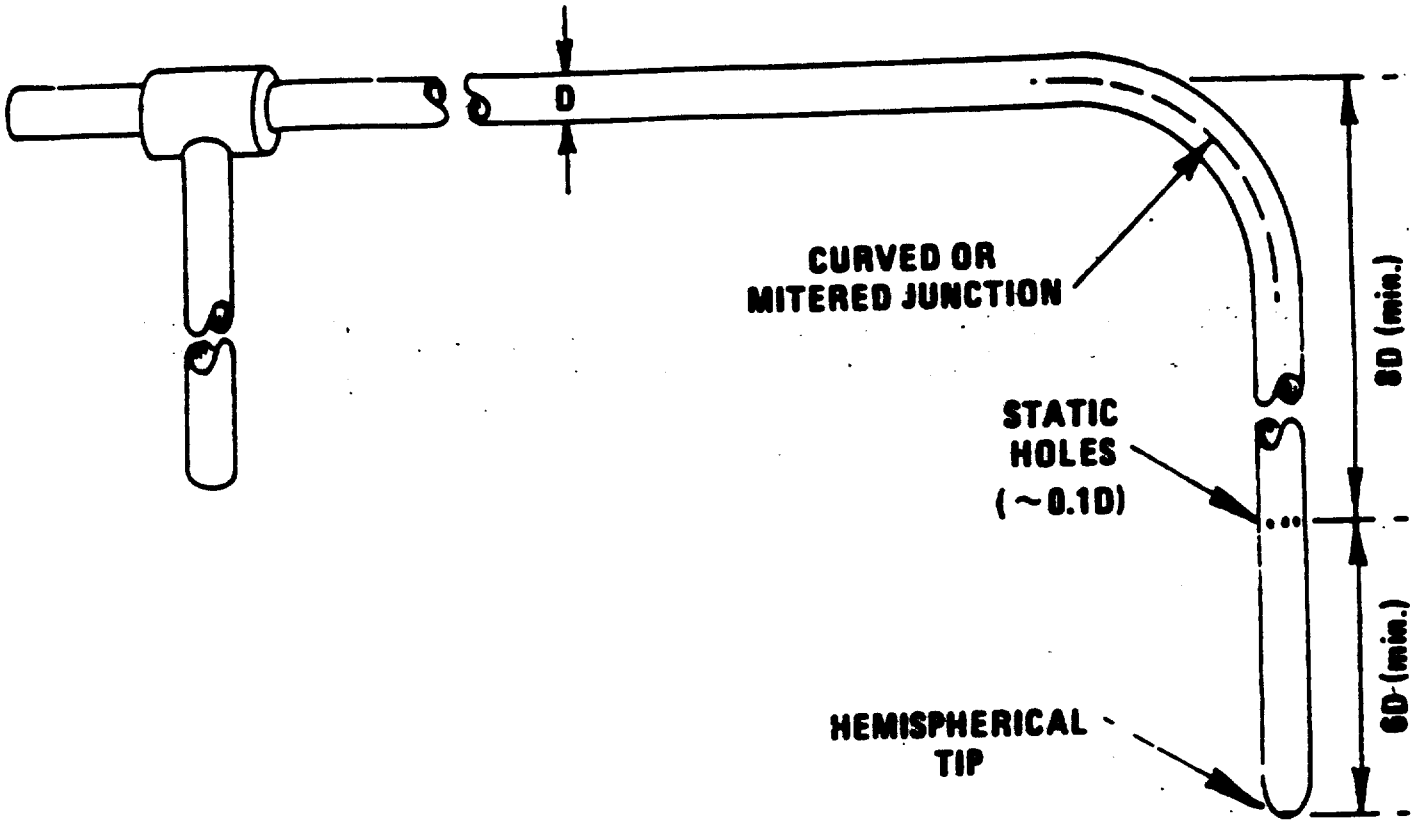


Figure 2-4. Standard pitot tube design specifications.

3. *Procedure*

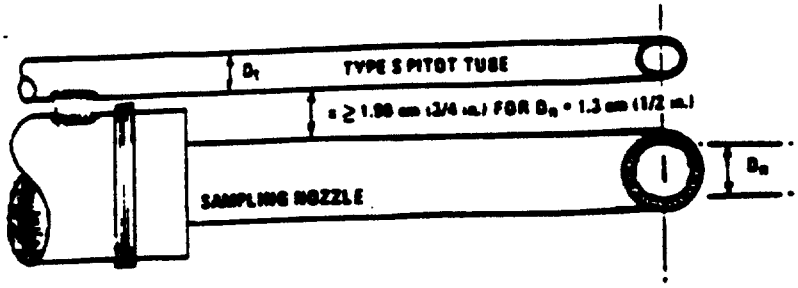
3.1 Set up the apparatus as shown in Figure 2-1. Capillary tubing or surge tanks installed between the manometer and pitot tube may be used to dampen Δp fluctuations. It is recommended, but not required, that a pretest leak-check be conducted, as follows: (1) blow through the pitot impact opening until at least 7.6 cm (3 in.) H_2O velocity pressure registers on the manometer; then, close off the impact opening. The pressure shall remain stable for at least 15 seconds; (2) do the same for the static pressure side, except using suction to obtain the minimum of 7.6 cm (3 in.) H_2O. Other leak-check procedures, subject to the approval of the Administrator may be used.

3.2 Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse. Record all necessary data as shown in the example data sheet (Figure 2-5).

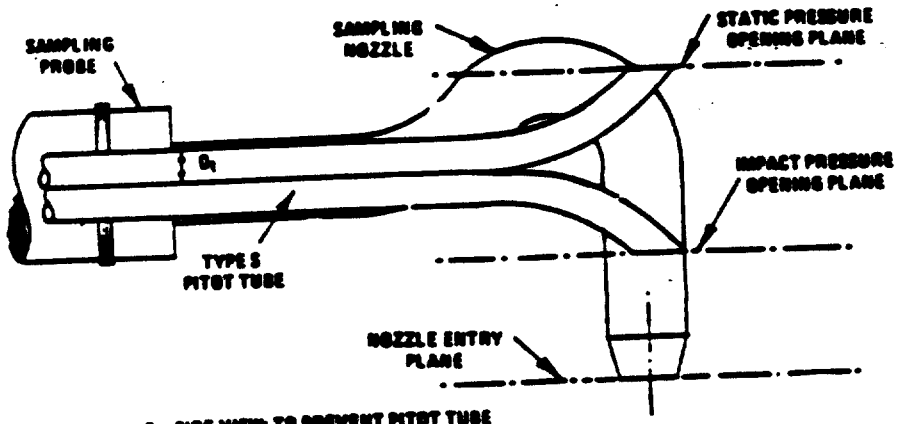
3.3 Measure the velocity head and temperature at the traverse points specified by Method 1. Ensure that the proper differential pressure gauge is being used for the range of Δp values encountered (see Section 2.2). If it is necessary to change to a more sensitive gauge, do so, and remeasure the Δp and temperature readings at each traverse point. Conduct a post-test leak-check (mandatory), as described in Section 3.1 above, to validate the traverse run.

3.4 Measure the static pressure in the stack. One reading is usually adequate.

3.5 Determine the atmospheric pressure.



A. BOTTOM VIEW: SHOWING MINIMUM PITOT-NOZZLE SEPARATION.



B. SIDE VIEW: TO PREVENT PITOT TUBE FROM INTERFERING WITH GAS FLOW STREAMLINES APPROACHING THE NOZZLE, THE IMPACT PRESSURE OPENING PLANE OF THE PITOT TUBE SHALL BE EVEN WITH OR ABOVE THE NOZZLE ENTRY PLANE.

Figure 2-6. Proper pitot tube-sampling nozzle configuration to prevent aerodynamic interference; buttonhook-type nozzle; centers of nozzle and pitot opening aligned; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

4.1.1 Type S Pitot Tube Assemblies. During sample and velocity traverses, the isolated Type S pitot tube is not always used: in many instances, the pitot tube is used in combination with other source-sampling components (thermocouple, sampling probe, nozzle) as part of an "assembly." The presence of other sampling components can sometimes affect the baseline value of the Type S pitot tube coefficient (Citation 9 in Section 6); therefore an assigned (or otherwise known) baseline coefficient value may or may not be valid for a given assembly. The baseline and assembly coefficient values will be identical only when the relative placement of the components in the assembly is such that aerodynamic interference effects are eliminated. Figures 2-6 through 2-8 illustrate interference-free component arrangements for Type S pitot tubes having external tubing diameters between 0.48 and 0.95 cm (3/16 and 3/8 in.). Type S pitot tube assemblies that fail to meet any or all of the specifications of Figures 2-6 through 2-8 shall be calibrated according to the procedure outlined in Sections 4.1.2 through 4.1.5 below, and prior to calibration, the values of the intercomponent spacings (pitot-nozzle, pitot-thermocouple, pitot-probe sheath) shall be measured and recorded.

Note: Do not use any Type S pitot tube assembly which is constructed such that the impact pressure opening plane of the pitot tube is below the entry plane of the nozzle (see Figure 2-6b).

4.1.2 Calibration Setup. If the Type S pitot tube is to be calibrated, one leg of the tube shall be permanently marked A, and the other, B. Calibration shall be done in a flow system having the following essential design features:

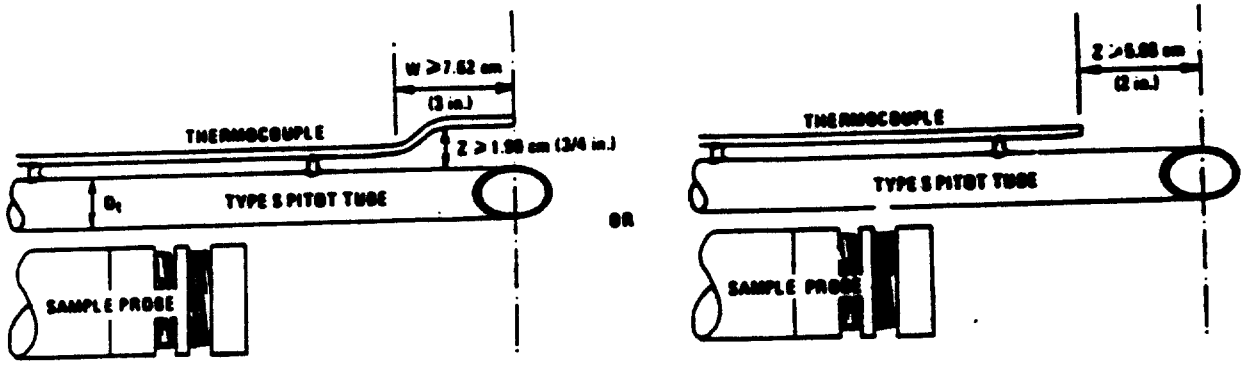


Figure 2-7. Proper thermocouple placement to prevent interference: D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

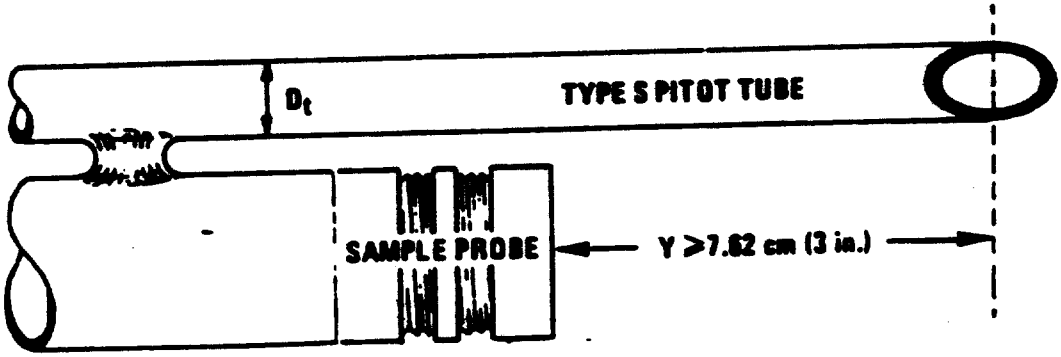


Figure 2-8. Minimum pitot-sample probe separation needed to prevent interference: D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

$$C_{p(std)} = C_{p(std)} \sqrt{\frac{\Delta p_{std}}{\Delta p_s}}$$

Equation 2-2

where:

$C_{p(std)}$ = Type S pitot tube coefficient

$C_{p(std)}$ = Standard pitot tube coefficient; use 0.99 if the coefficient is unknown and the tube is designed according to the criteria of Sections 2.7.1 to 2.7.5 of this method.

Δp_{std} = Velocity head measured by the standard pitot tube, cm H_2O (in. H_2O)

Δp_s = Velocity head measured by the Type S pitot tube, cm H_2O (in H_2O)

4.1.4.2 Calculate $\bar{C}_s$ (side A), the mean A-side coefficient, and $\bar{C}_s$ (side B), the mean B-side coefficient; calculate the difference between these two average values.

4.1.4.3 Calculate the deviation of each of the three A-side values of $C_{p(std)}$ from $\bar{C}_s$ (side A), and the deviation of each B-side value of $C_{p(std)}$ from $\bar{C}_s$ (side B). Use the following equation:

$$\text{Deviation} = C_{p(std)} - \bar{C}_s(\text{A or B})$$

Equation 2-3

4.1.4.4 Calculate σ, the average deviation from the mean, for both the A and B sides of the pitot tube. Use the following equation:

$$\sigma\,(\text{side A or B}) = \frac{\sum_{1}^{3} |C_{p(std)} - \bar{C}_s(A \text{ or } B)|}{3}$$

Equation 2-4

4.1.4.5 Use the Type S pitot tube only if the values of σ (side A) and σ (side B) are less than or equal to 0.01 and if the absolute value of the difference between $\bar{C}_s$ (A) and $\bar{C}_s$ (B) is 0.01 or less.

4.1.5 Special considerations.

4.1.5.1 Selection of calibration point.

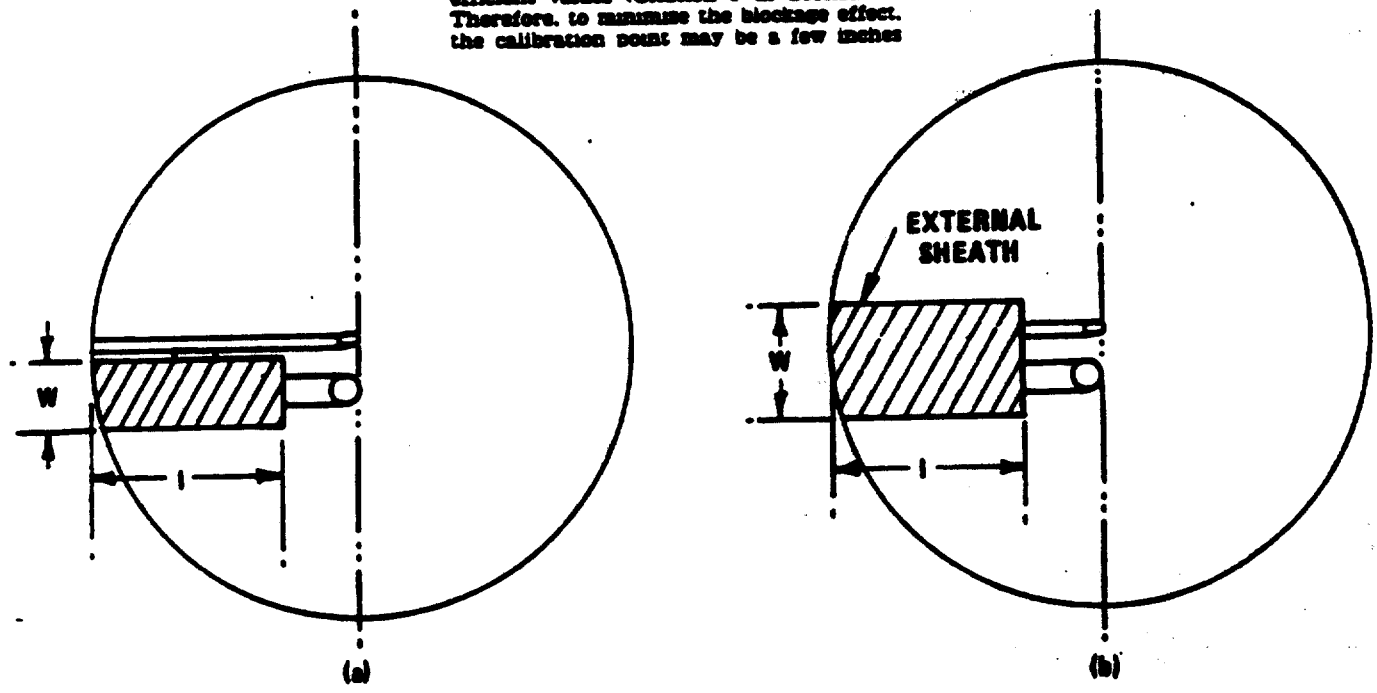
4.1.5.1.1 When an isolated Type S pitot tube is calibrated, select a calibration point at or near the center of the duct, and follow the procedures outlined in Sections 4.1.3 and 4.1.4 above. The Type S pitot coefficients so obtained, i.e., $\bar{C}_s$ (side A) and $\bar{C}_s$ (side B), will be valid, so long as either: (1) the isolated pitot tube is used; or (2) the pitot tube is used with other components (nozzle, thermocouple, sample probe) in an arrangement that is free from aerodynamic interference effects (see Figures 2-6 through 2-8).

4.1.5.1.2 For Type S pitot tube-thermocouple combinations (without sample probe), select a calibration point at or near the center of the duct, and follow the procedures outlined in Sections 4.1.3 and 4.1.4 above. The coefficients so obtained will be valid so long as the pitot tube-thermocouple combination is used by itself or with other components in an interference-free arrangement (Figures 2-6, and 2-8).

4.1.5.1.3 For assemblies with sample probes, the calibration point should be located at or near the center of the duct; however, insertion of a probe sheath into a small duct may cause significant cross-sectional area blockage and yield incorrect coefficient values (Citation 9 in Section 6). Therefore, to minimize the blockage effect, the calibration point may be a few inches off-center if necessary. The actual blockage effect will be negligible when the theoretical blockage, as determined by a projected-area model of the probe sheath, is 2 percent or less of the duct cross-sectional area for assemblies without external sheaths (Figure 2-10a), and 3 percent or less for assemblies with external sheaths (Figure 2-10b).

4.1.5.2 For those probe assemblies in which pitot tube-nozzle interference is a factor (i.e., those in which the pitot-nozzle separation distance fails to meet the specifications illustrated in Figure 2-6a), the value of $C_{p(std)}$ depends upon the amount of free-space between the pitot tube and nozzle, and therefore is a function of nozzle size. In these instances, separate calibrations shall be performed with each of the commonly used nozzle sizes in place. Note that the single-velocity calibration technique is acceptable for this purpose, even though the larger nozzle sizes (>0.635 cm or ¼ in.) are not ordinarily used for isokinetic sampling at velocities around 915 m/min (3,000 ft/min), which is the calibration velocity; note also that it is not necessary to draw an isokinetic sample during calibration (see Citation 19 in Section 6).

4.1.5.3 For a probe assembly constructed such that its pitot tube is always used in the same orientation, only one side of the pitot tube need be calibrated (the side which will face the flow). The pitot tube must still meet the alignment specifications of Figure 2-3 or 2-3, however, and must have an average deviation (σ) value of 0.01 or less (see Section 4.1.4.4).



$$\text{ESTIMATED SHEATH BLOCKAGE (\%)} = \left[\frac{l \times W}{\text{DUCT AREA}}\right] \times 100$$

Figure 2-10. Projected-area models for typical pitot tube assemblies.

METHOD 3—GAS ANALYSIS FOR CARBON DIOXIDE, OXYGEN, EXCESS AIR, AND DRY MOLECULAR WEIGHT

1. *Principle and Applicability*

1.1 Principle. A gas sample is extracted from a stack, by one of the following methods: (1) single-point, grab sampling; (2) single-point, integrated sampling; or (3) multi-point, integrated sampling. The gas sample is analyzed for percent carbon dioxide (CO_2), percent oxygen (O_2), and, if necessary, percent carbon monoxide (CO). If a dry molecular weight determination is to be made, either an Orsat or a Fyrite[1] analyzer may be used for the analysis; for excess air or emission rate correction factor determination, an Orsat analyzer must be used.

1.2 Applicability. This method is applicable for determining CO_2 and O_2 concentrations, excess air, and dry molecular weight of a sample from a gas stream of a fossil-fuel combustion process. The method may also be applicable to other processes where it has been determined that compounds other than CO_2, O_2, CO, and nitrogen (N_2) are not present in concentrations sufficient to affect the results.

Other methods, as well as modifications to the procedure described herein, are also applicable for some or all of the above determinations. Examples of specific methods and modifications include: (1) a multi-point sampling method using an Orsat analyzer to analyze individual grab samples obtained at each point; (2) a method using CO, or O_2 and stoichiometric calculations to determine dry molecular weight and excess air; (3) assigning a value of 30.0 for dry molecular weight, in lieu of actual measurements, for processes burning natural gas, coal, or oil. These methods and modifications may be used, but are subject to the approval of the Administrator, U.S. Environmental Protection Agency.

2. *Apparatus*

As an alternative to the sampling apparatus and systems described herein, other sampling systems (e.g., liquid displacement) may be used provided such systems are capable of obtaining a representative sample and maintaining a constant sampling rate, and are otherwise capable of yielding acceptable results. Use of such systems is subject to the approval of the Administrator.

2.1 Grab Sampling (Figure 3-1).

2.1.1 Probe. The probe should be made of stainless steel or borosilicate glass tubing and should be equipped with an in-stack or out-stack filter to remove particulate matter (a plug of glass wool is satisfactory for this purpose). Any other materials inert to O_2, CO_2, CO, and N_2 and resistant to temperature at sampling conditions may be used for the probe; examples of such material are aluminum, copper, quartz glass and Teflon.

2.1.2 Pump. A one-way squeeze bulb, or equivalent, is used to transport the gas sample to the analyzer.

2.2 Integrated Sampling (Figure 3-2).

2.2.1 Probe. A probe such as that described in Section 2.1.1 is suitable.

2.2.2 Condenser. An air-cooled or water-cooled condenser, or other condenser that will not remove O_2, CO_2, CO, and N_2 may be used to remove excess moisture which would interfere with the operation of the pump and flow meter.

2.2.3 Valve. A needle valve is used to adjust sample gas flow rate.

2.2.4 Pump. A leak-free, diaphragm-type pump, or equivalent, is used to transport sample gas to the flexible bag. Install a small surge tank between the pump and rate meter to eliminate the pulsation effect of the diaphragm pump on the rotameter.

2.2.5 Rate Meter. The rotameter, or equivalent rate meter, used should be capable of measuring flow rate to within ±2 percent of the selected flow rate. A flow rate range of 500 to 1000 cm^3/min is suggested.

2.2.6 Flexible Bag. Any leak-free plastic (e.g., Tedlar, Mylar, Teflon) or plastic-coated aluminum (e.g., aluminized Mylar) bag, or equivalent, having a capacity consistent with the selected flow rate and time length of the test run, may be used. A capacity in the range of 55 to 90 liters is suggested.

To leak-check the bag, connect it to a water manometer and pressurize the bag to 5 to 10 cm H_2O (2 to 4 in. H_2O). Allow to stand for 10 minutes. Any displacement in the water manometer indicates a leak. An alternative leak-check method is to pressurize the bag to 5 to 10 cm H_2O (2 to 4 in. H_2O) and allow to stand overnight. A deflated bag indicates a leak.

2.2.7 Pressure Gauge. A water-filled U-tube manometer, or equivalent, of about 30 cm (12 in.) is used for the flexible bag leak-check.

2.2.8 Vacuum Gauge. A mercury manometer, or equivalent, of at least 760 mm Hg (30 in. Hg) is used for the sampling train leak-check.

2.3 Analysis. For Orsat and Fyrite analyzer maintenance and operation procedures, follow the instructions recommended by the manufacturer, unless otherwise specified herein.

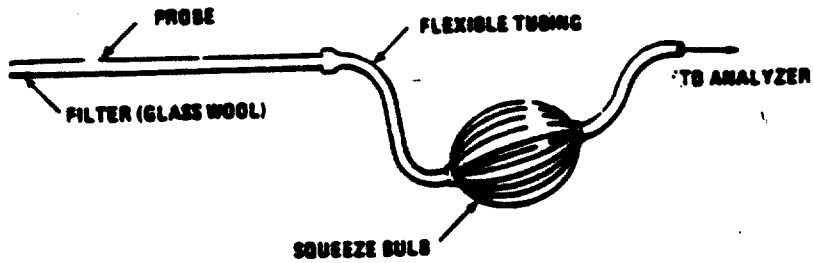


Figure 3-1. Grab-sampling train.

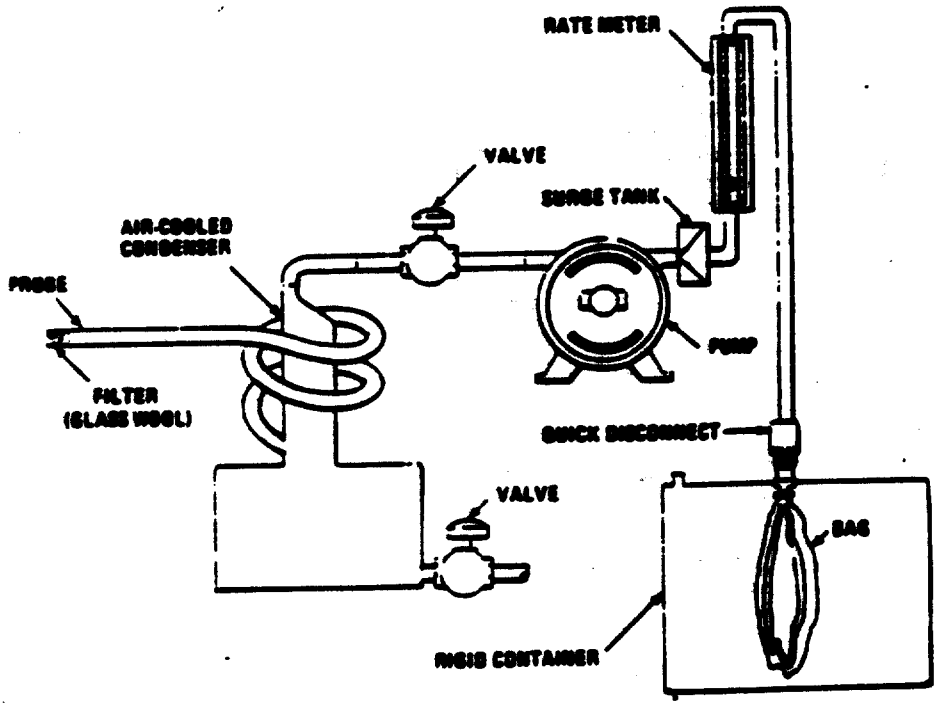


Figure 3-2. Integrated gas-sampling train.

[1] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

4.2.5 To insure complete absorption of the CO_2, O_2, or if applicable, CO, make repeated passes through each absorbing solution until two consecutive readings are the same. Several passes (three of four) should be made between readings. (If consistent readings cannot be obtained after three consecutive readings, replace the absorbing solution.)

4.2.6 Repeat the analysis until the following criteria are met:

4.2.6.1 For percent CO_2, repeat the analytical procedure until the results of any three analyses differ by no more that (a) 0.3 percent by volume when CO_2 is greater than 4.0 percent or (b) 0.2 percent by volume when CO_2 is less than or equal to 4.0 percent. Average the three acceptable values of percent CO_2 and report the results to the nearest 0.1 percent.

4.2.6.2 For percent O_2, repeat the analytical procedure until the results of any three analyses differ by no more than (a) 0.3 percent by volume when O_2 is less than 15.0 percent or (b) 0.2 percent by volume when O_2 is greater than or equal to 15.0 percent. Average the three acceptable values of percent O_2 and report the results to the nearest 0.1 percent.

4.2.6.3 For percent CO, repeat the analytical procedure until the results of any three analyses differ by no more than 0.3 percent. Average the three acceptable values of percent CO and report the results to the nearest 0.1 percent.

4.2.7 After the analysis is completed, leak-check (mandatory) the Orsat analyzer once again, as described in Section 5. For the results of the analysis to be valid, the Orsat analyzer must pass this leak test before and after the analysis.

NOTE: Although in most instances only CO_2 or O_2 is required, it is recommended that both CO_2 and O_2 be measured, and that Section 4.4.1 be used to validate the analytical data.

4.3 Multi-Point, Integrated Sampling and Analytical Procedure.

4.3.1 Both the minimum number of sampling points and the sampling point location shall be as specified in Section 3.3.1 of this method. The use of fewer points than specified is subject to the approval of the Administrator.

4.3.2 Follow the procedures outlined in Sections 4.2.2 through 4.2.7, except for the following: Traverse all sampling points and sample at each point for an equal length of time. Record sampling data as shown in Figure 3-3.

4.4 Quality Control Procedures.

4.4.1 Data Validation When Both CO_2 and O_2 Are Measured. Although in most instances, only CO_2 or O_2 measurement is required, it is recommended that both CO_2 and O_2 be measured to provide a check on the quality of the data. The following quality control procedure is suggested.

NOTE: Since the method for validating the CO_2 and O_2 analyses is based on combustion of organic and fossil fuels and dilution of the gas stream with air, this method does not apply to sources that (1) remove CO_2 or O_2 through processes other than combustion, (2) add O_2 (e.g., oxygen enrichment) and N_2 in proportions different from that of air, (3) add CO_2 (e.g., cement or lime kilns), or (4) have no fuel factor, F_o, values obtainable (e.g., extremely variable waste mixtures). This method validates the measured proportions of CO_2 and O_2 for the fuel type, but the method does not detect sample dilution resulting from leaks during or after sample collection. The method is applicable for samples collected downstream of most lime or limestone flue-gas desulfurization units as the CO_2 added or removed from the gas stream is not significant in relation to the total CO_2 concentration. The CO_2 concentrations from other types of scrubbers using only water or basic slurry can be significantly affected and would render the F_o check minimally useful.

4.4.1.1 Calculate a fuel factor, F_o, using the following equation:

$$F_o = \frac{20.9 - \%O_2}{\%CO_2}$$

Eq. 3-3

Where:
$\%O_2$ = Percent O_2 by volume (dry basis).
$\%CO_2$ = Percent CO_2 by volume (dry basis).
20.9 = Percent O_2 by volume in ambient air.

If CO is present in quantities measurable by this method, adjust the O_2 and CO_2 values before performing the calculation for F_o as follows:

$$\%CO_2(adj) = \%CO_2 + \%CO$$

$$\%O_2(adj) = \%O_2 - 0.5\ \%CO$$

Where: %CO = Percent CO by volume (dry basis).

4.4.1.2 Compare the calculated F_o factor with the expected F_o values. The following table may be used in establishing acceptable ranges for the expected F_o if the fuel being burned is known. When fuels are burned in combination, calculate the combined fuel F_o and F_c factors (as defined in Method 19) according to the procedure in Method 19 Section 5.2.3. Then calculate the F_o factor as follows:

$$F_o = \frac{0.209\ F_c}{F_c}$$

Eq. 3-4

Fuel type	F_o range
Coal:	
Anthracite and lignite	1.016–1.130
Bituminous	1.083–1.230
Oil:	
Distillate	1.260–1.413
Residual	1.210–1.370
Gas:	
Natural	1.600–1.836
Propane	1.434–1.586
Butane	1.405–1.582
Wood	1.000–1.120
Wood bark	1.003–1.130

Calculated F_o values beyond the acceptable ranges shown in this table should be investigated before accepting the test results. For example, the strength of the solutions in the gas analyzer and the analyzing technique should be checked by sampling and analyzing a known concentration, such as air; the fuel factor should be reviewed and verified. An acceptability range of ±12 percent is appropriate for the F_o factor of mixed fuels with variable fuel ratios. The level of the emission rate relative to the compliance level should be considered in determining if a retest is appropriate, i.e., if the measured emissions are much lower or much greater than the compliance limit, repetition of the test would not significantly change the compliance status of the source and would be unnecessarily time-consuming and costly.

5. *Leak-Check Procedure for Orsat Analyzers*

Moving an Orsat analyzer frequently causes it to leak. Therefore, an Orsat analyzer should be thoroughly leak-checked on site before the flue gas sample is introduced into it. The procedure for leak-checking an Orsat analyzer is:

5.1.1 Bring the liquid level in each pipette up to the reference mark on the capillary tubing and then close the pipette stopcock.

5.1.2 Raise the leveling bulb sufficiently to bring the confining liquid meniscus onto the graduated portion of the burette and then close the manifold stopcock.

5.1.3 Record the meniscus position.

5.1.4 Observe the meniscus in the burette and the liquid level in the pipette for movement over the next 4 minutes.

5.1.5 For the Orsat analyzer to pass the leak-check, two conditions must be met.

5.1.5.1 The liquid level in each pipette must not fall below the bottom of the capillary tubing during this 4-minute interval.

5.1.5.2 The meniscus in the burette must not change by more than 0.3 ml during this 4-minute interval.

5.1.6 If the analyzer fails the leak-check procedure, all rubber connections and stopcocks should be checked until the cause of the leak is identified. Leaking stopcocks must be disassembled, cleaned, and regreased. Leaking rubber connections must be replaced. After the analyzer is reassembled, the leak-check procedure must be repeated.

6. *Calculations*

6.1 Nomenclature.

M_d = Dry molecular weight, g/g-mole (lb/lb-mole).
%EA = Percent excess air.
$\%CO_2$ = Percent CO_2 by volume (dry basis).
$\%O_2$ = Percent O_2 by volume (dry basis).
%CO = Percent CO by volume (dry basis).
$\%N_2$ = Percent N_2 by volume (dry basis).
0.264 = Ratio of O_2 to N_2 in air, v/v.
0.280 = Molecular weight of N_2 or CO, divided by 100.
0.320 = Molecular weight of O_2 divided by 100.
0.440 = Molecular weight of CO_2 divided by 100.

6.2 Percent Excess Air. Calculate the percent excess air (if applicable), by substituting the appropriate values of percent O_2, CO, and N_2 (obtained from Section 4.1.3 or 4.2.4) into Equation 3-1.

$$\%EA = \frac{\%O_2 - 0.5\%\ CO}{0.264\%\ N_2 - (\%O_2 - 0.5\ \%\ CO)} \times 100$$

Equation 3-1

NOTE: The equation above assumes that ambient air is used as the source of O_2 and that the fuel does not contain appreciable amounts of N_2 (as do coke oven or blast furnace gases). For those cases when appreciable amounts of N_2 are present (coal, oil, and natural gas do not contain appreciable amounts of N_2) or when oxygen enrichment is used, alternate methods, subject to approval of the Administrator, are required.

6.3 Dry Molecular Weight. Use Equation 3-2 to calculate the dry molecular weight of the stack gas:

$$M_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$$

Equation 3-2

METHODOLOGY FOR THE DETERMINATION OF METALS EMISSIONS IN EXHAUST GASES FROM HAZARDOUS WASTE INCINERATION AND SIMILAR COMBUSTION PROCESSES

1. Applicability and Principle

1.1 Applicability. This method is being developed for applicability for the determination of total chromium (Cr), cadmium (Cd), arsenic (As), nickel (Ni), manganese (Mn), beryllium (Be), copper (Cu), zinc (Zn), lead (Pb), selenium (Se), phosphorus (P), thallium (Tl), silver (Ag), antimony (Sb), barium (Ba), and mercury (Hg) stack emissions from hazardous waste incinerators and similar combustion processes. This method may also be used for the determination of particulate emissions following the procedures and precautions described. Modifications to the sample recovery and analysis procedures described in this protocol for the purpose of determining particulate emissions may potentially impact the front-half mercury determination.

1.2 Principle. The stack sample is withdrawn isokinetically from the source, with particulate emissions collected in the probe and on a heated filter and gaseous emissions collected in a series of chilled impingers containing an aqueous solution of dilute nitric acid combined with dilute hydrogen peroxide in each of two impingers, and acidic potassium permanganate solution in each of two impingers. Sampling train components are recovered and digested in separate front- and back-half fractions. Materials collected in the sampling train are digested with acid solutions to dissolve inorganics and to remove organic constituents that may create analytical interferences. Acid digestion is performed using conventional Parr® Bomb or microwave digestion techniques. The nitric acid and hydrogen peroxide impinger solution, the acidic potassium permanganate impinger solution, the HCl rinse solution, and the probe rinse and digested filter solutions are analyzed for mercury by cold vapor atomic absorption spectroscopy (CVAAS). The nitric acid and hydrogen peroxide solution and the probe rinse and digested filter solutions of the train catches are analyzed for Cr, Cd, Ni, Mn, Be, Cu, Zn, Pb, Se, P, Tl, Ag, Sb, Ba, and As by inductively coupled argon plasma emission spectroscopy (ICAP) or atomic absorption spectroscopy (AAS). Graphite furnace atomic absorption spectroscopy (GFAAS) is used for analysis of antimony, arsenic, cadmium, lead, selenium, and thallium, if these elements require greater analytical

for the following metals: Sb (3 ng/mL), As (1 ng/mL), Be (0.2 ng/mL), Cd (0.2 ng/mL), Cr (1 ng/mL), Pb (1 ng/mL), Se (2 ng/mL), and Tl (1 ng/mL).

Using (1) the procedures described in this method, (2) the analytical detection limits described in the previous paragraph, (3) a volume of 300 mL, Fraction 1, for the front half and 150 mL, Fraction 2A, for the back-half samples, and (4) a stack gas sample volume of 1.25 m^3, the corresponding in-stack method detection limits are presented in Table A-1 and calculated as shown:

$$\frac{A \times B}{C} = D$$

where: A = analytical detection limit, ug/mL.
B = volume of sample prior to aliquot for analysis, mL.
C = stack sample volume, dscm (dsm^3).
D = in-stack detection limit, ug/m^3.

Values in Table A-1 are calculated for the front and back half and/or the total train.

To ensure optimum sensitivity in obtaining the measurements, the concentrations of target metals in the solutions are suggested to be at least ten times the analytical detection limits. Under certain conditions, and with greater care in the analytical procedure, this concentration can be as low as approximately three times the analytical detection limit. In all cases, on at least one sample (run) in the source test and for each metal analyzed, repetitive analyses, method of standard additions (MSA), serial dilution, or matrix spike addition, etc., shall be used to establish the quality of the data.

Actual in-stack method detection limits will be determined based on actual source sampling parameters and analytical results as described above. If required, the method in-stack detection limits can be made more sensitive than those shown in Table A-1 for a specific test by using one or more of the following options:

- A 1-hour sampling run may collect a stack gas sampling volume of about 1.25 m^3. If the sampling time is increased and 5 m^3 are collected, the in-stack method detection limits would be one fourth of the values shown in Table A-1 (this means that with this change, the method is four times more sensitive than a 1-hour run. Larger sample volumes (longer runs) would make it even more sensitive).

- When both of the above two improvements are used on one sample at the same time, the resultant improvements are multiplicative. For example, where stack gas volume is increased by a factor of five and the total liquid sample digested volume of both the front and back halves is reduced by factor of six, the in-stack method detection limit is reduced by a factor of thirty (the method is thirty times more sensitive).
- Conversely, reducing stack gas sample volume and increasing sample liquid volume will increase in-stack detection limits (the method would then be less sensitive). The front-half and back-half samples (Fractions 1A plus and 2A) can be combined proportionally (see Section 1.2 of this methodology) prior to analysis. The resultant liquid volume (excluding the mercury fractions, which must be analyzed separately) is recorded. Combining the sample as described does not allow determination (whether front or back half) of where in the train the sample was captured. The in-stack method detection limit then becomes a single value for all metals except mercury, for which the contribution of the mercury fractions must be considered.
- The above discussion assumes no blank correction. Blank corrections are discussed later in this method.

2.3 Precision. The precisions (relative standard deviation) for each metal detected in a method development test at a sewage sludge incinerator, are as follows: Sb (12.7%), As (13.5%), Ba (20.6%), Cd (11.5%), Cr (11.2%), Cu (11.5%), Pb (11.6%), P (14.6%), Se (15.3%), Tl (12.3%), and Zn (11.8%). The precision for nickel was 7.7% for another test conducted at a source simulator. Beryllium, manganese and silver were not detected in the tests; however, based on the analytical sensitivity of the ICAP for these metals, it is assumed that their precisions should be similar to those for the other metals, when detected at similar levels.

2.4 Interferences. Iron can be a spectral interference during the analysis of arsenic, chromium, and cadmium by ICAP. Aluminum can be a spectral interference during the analysis of arsenic and lead by ICAP. Generally, these interferences can be reduced by diluting the sample, but this increases the method detection limit (in-stack detection limit). Refer to EPA Method 6010 (SW-846) or the other analytical methods used for details on potential interferences for this method. The analyst must eliminate or reduce

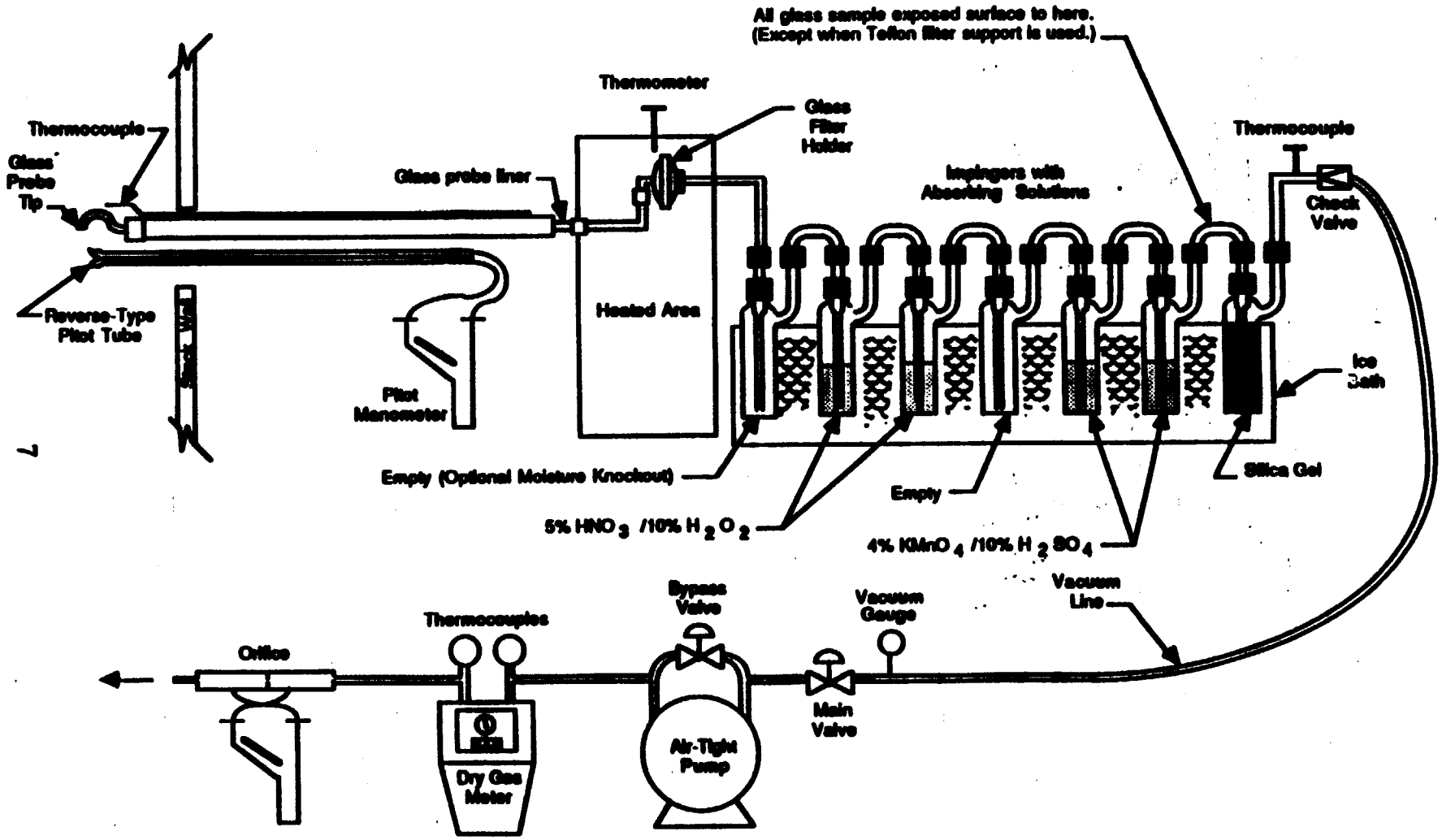


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Figure A-1. Schematic of multiple metals sampling train configuration.

3.3.1 Volumetric Flasks, 100-mL, 250-mL, and 1000-mL. For preparation of standards and sample dilution.

3.3.2 Graduated Cylinders. For preparation of reagents.

3.3.3 Parr® Bombs or Microwave Pressure Relief Vessels with Capping Station (CEM Corporation model or equivalent).

3.3.4 Beakers and Watchglasses. 250-mL beakers for sample digestion with watchglasses to cover the tops.

3.3.5 Ring Stands and Clamps. For securing equipment such as filtration apparatus.

3.3.6 Filter Funnels. For holding filter paper.

3.3.7 Whatman 541 Filter Paper (or equivalent). For filtration of digested samples.

3.3.8 Disposable Pasteur Pipets and Bulbs.

3.3.9 Volumetric Pipets.

3.3.10 Analytical Balance. Accurate to within 0.1 mg.

3.3.11 Microwave or Conventional Oven. For heating samples at fixed power levels or temperatures.

3.3.12 Hot Plates.

3.3.13 Atomic Absorption Spectrometer (AAS). Equipped with a background corrector.

3.3.13.1 Graphite Furnace Attachment. With antimony, arsenic, cadmium, lead, selenium, thallium, and hollow cathode lamps (HCLs) or electrodeless discharge lamps (EDLs). Same as EPA SW-846 Methods 7041 (antimony), 7060 (arsenic), 7131 (cadmium), 7421 (lead), 7740 (selenium), and 7841 (thallium).

3.3.13.2 Cold Vapor Mercury Attachment. With a mercury HCL or EDL. The equipment needed for the cold vapor mercury attachment includes an air recirculation pump, a quartz cell, an aerator apparatus, and a heat lamp or desiccator tube. The heat lamp should be capable of raising the ambient temperature at the quartz cell by 10°C such that no condensation forms on the wall of the quartz cell. Same as EPA Method 7470.

3.3.14 Inductively Coupled Argon Plasma Spectrometer. With either a direct or sequential reader and an alumina torch. Same as EPA Method 6010.

4. Reagents

The complexity of this methodology is such that to obtain reliable results, the testers (including analysts) should be experienced and knowledgeable in

of water, and then add carefully with stirring 333 mL of 30 percent H_2O_2. Dilute to volume with water. Mix well. The reagent shall contain less than 2 ng/mL of each target metal.

4.2.2 Acidic Potassium Permanganate ($KMnO_4$) Absorbing Solution. 4 Percent $KMnO_4$ (W/V), 10 Percent H_2SO_4 (V/V). Prepare fresh daily. Mix carefully, with stirring, 100 mL of concentrated H_2SO_4 into 800 mL of water, and add water with stirring to make a volume of 1 L: this solution is 10 percent H_2SO_4 (V/V). Dissolve, with stirring, 40 g of $KMnO_4$ into 10 percent H_2SO_4 (V/V) and add 10 percent H_2SO_4 (V/V) with stirring to make a volume of 1 L: this is the acidic potassium permanganate absorbing solution. Prepare and store in glass bottles to prevent degradation. The reagent shall contain less than 2 ng/mL of Hg.

Precaution: To prevent autocatalytic decomposition of the permanganate solution, filter the solution through Whatman 541 filter paper. Also, due to the potential reaction of the potassium permanganate with the acid, there may be pressure buildup in the sample storage bottle; these bottles shall not be fully filled and shall be vented both to relieve potential excess pressure and prevent explosion due to pressure buildup. Venting is required, but should not allow contamination of the sample; a No. 70-72 hole drilled in the container cap and Teflon liner has been used.

4.2.3 Nitric Acid, 0.1 N. Add with stirring 6.3 mL of concentrated HNO_3 (70 percent) to a flask containing approximately 900 mL of water. Dilute to 1000 mL with water. Mix well. The reagent shall contain less than 2 ng/mL of each target metal.

4.2.4 Hydrochloric Acid (HCl), 8 N. Make the desired volume of 8N HCl in the following proportions. Carefully add with stirring, 690 mL of concentrated HCl to a flask containing 250 mL of water. Dilute to 1000 mL with water. Mix well. The reagent shall contain less than 2 ng/mL of Hg.

4.3 Glassware Cleaning Reagents.

4.3.1 Nitric Acid, Concentrated. Fisher ACS grade or equivalent.

4.3.2 Water. To conform to ASTM Specifications D1193-77, Type II.

4.3.3 Nitric Acid, 10 Percent (V/V). Add with stirring 500 mL of concentrated HNO_3 to a flask containing approximately 4000 mL of water. Dilute to 5000 mL with water. Mix well. Reagent shall contain less than 2 ng/mL of each target metal.

Method 5, Section 4.1.1, except that, unless particulate emissions are to be determined, the filter need not be desiccated or weighed. All sampling train glassware should first be rinsed with hot tap water and then washed in hot soapy water. Next, glassware should be rinsed three times with tap water, followed by three additional rinses with water. All glassware should then be soaked in a 10 percent (V/V) nitric acid solution for a minimum of 4 hours, rinsed three times with water, rinsed a final time with acetone, and allowed to air dry. All glassware openings where contamination can occur should be covered until the sampling train is assembled for sampling.

5.1.2 Preliminary Determinations. Same as Method 5, Section 4.1.2.

5.1.3 Preparation of Sampling Train. Follow the same general procedures given in Method 5, Section 4.1.3, except place 100 mL of the nitric acid/hydrogen peroxide solution (Section 4.2.1) in each of the two HNO_3/H_2O_2 impingers as shown in Figure A-1 (normally the second and third impingers), place 100 mL of the acidic potassium permanganate absorbing solution (Section 4.2.2) in each of the two permanganate impingers as shown in Figure A-1, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the last impinger. Alternatively, the silica gel may be weighed directly in the impinger just prior to train assembly.

Several options are available to the tester based on the sampling requirements and conditions. The use of an empty first impinger can be eliminated if the moisture to be collected in the impingers will be less than approximately 100 mL. If necessary, use as applicable to this methodology the procedure described in Section 7.1.1 of EPA Method 101A, 40 CFR Part 61, Appendix B, to maintain the desired color in the last permanganate impinger.

Retain for reagent blanks volumes of the nitric acid/hydrogen peroxide solution per Section 5.2.9 of this method and of the acidic potassium permanganate solution per Section 5.2.10. These reagent blanks should be labeled and analyzed as described in Section 7. Set up the sampling train as shown in Figure A-1, or if mercury analysis is not to be performed in the train, then it should be modified by removing the three impingers which are the two permanganate impingers and the impinger preceding the permanganate impingers. If necessary to ensure leak-free sampling train connections, Teflon tape or other non-contaminating material should be used instead of silicone grease to prevent contamination.

stirring into Container No. 1.A. Analyze the HCl rinse separately by carefully diluting with stirring the contents of Container No. 1.A. to 500 mL with deionized distilled water. Filter (if necessary) through Whatman 40 filter paper, and then analyze for mercury according to Section 7.4, except limit the aliquot size to a maximum of 10 mL. Prepare and analyze a water diluted blank 8 N HCL sample by using the same procedure as that used by Container No. 1.A., except add 5 mL of 8 N HCl with stirring to 40 mL of water, and then dilute to 100 mL with water. Then analyze as instructed for the sample from Container No. 1.A. Because the previous separate permanganate solution rinse (Section 7.2.1) and water rinse (as modified in these guidelines) have the capability to recover a very high percentage of the mercury from the permanganate impingers, the amount of mercury in the HCl rinse in Container No. 1.A. may be very small, possibly even insignificantly small. However, add the total of any mercury analyzed and calculated for the HCl rinse sample Container No. 1.A. to that calculated from the mercury sample from Section 7.3.2 which contains the separate permanganate rinse (and water rinse as modified herein) for calculation of the total sample mercury concentration.]

5.1.4 Leak-Check Procedures. Follow the leak-check procedures given in Method 5, Section 4.1.4.1 (Pretest Leak-Check), Section 4.1.4.2 (Leak-Checks During the Sample Run), and Section 4.1.4.3 (Post-Test Leak-Checks).

5.1.5 Sampling Train Operation. Follow the procedures given in Method 5, Section 4.1.5. For each run, record the data required on a data sheet such as the one shown in Figure 5-2 of Method 5.

5.1.6 Calculation of Percent Isokinetic. Same as Method 5, Section 4.1.6.

5.2 Sample Recovery. Begin cleanup procedures as soon as the probe is removed from the stack at the end of a sampling period.

The probe should be allowed to cool prior to sample recovery. When it can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a rinsed, non-contaminating cap over the probe nozzle to prevent losing or gaining particulate matter. Do not cap the probe tip tightly while the sampling train is cooling. This normally causes a vacuum

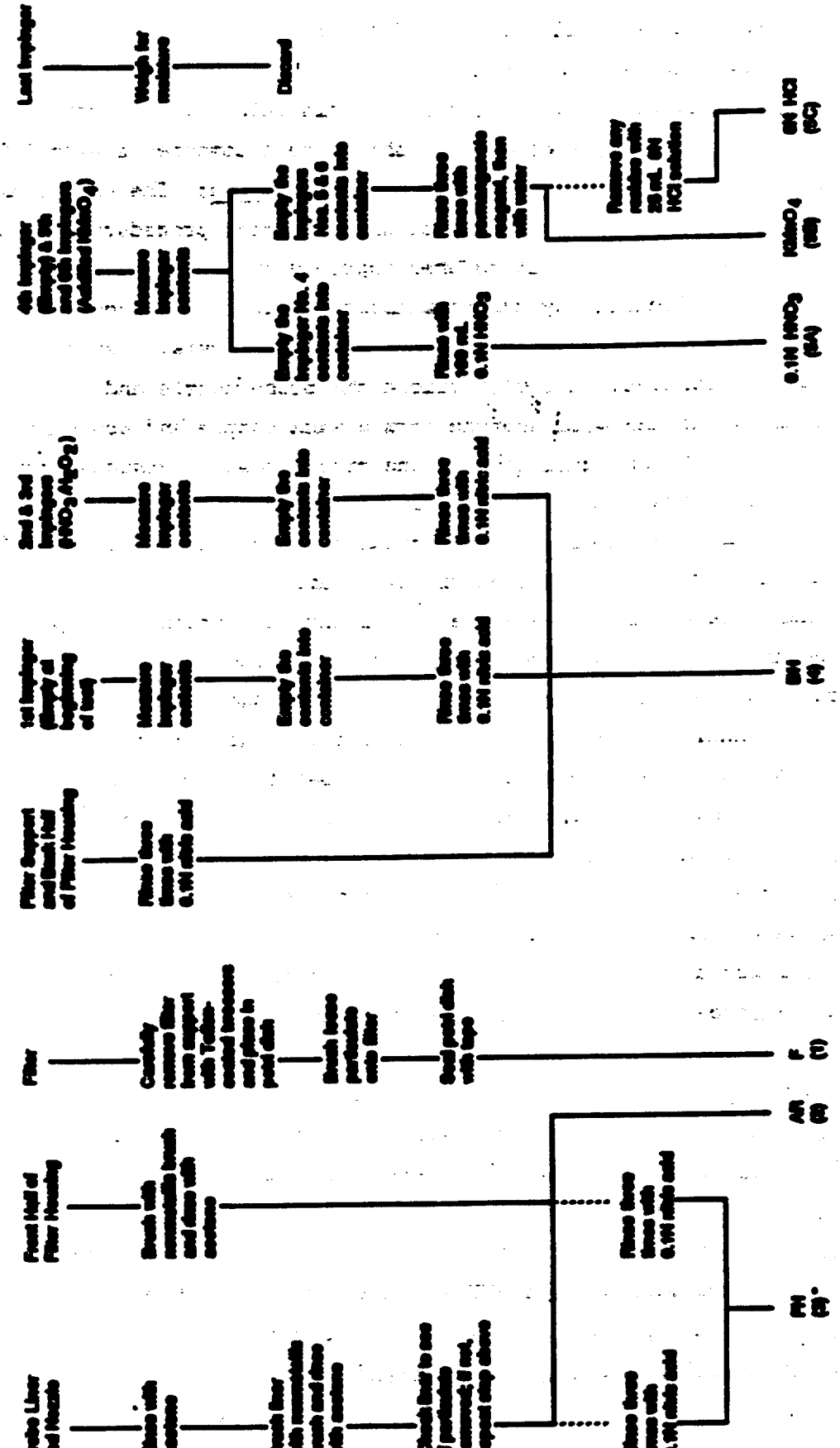


Figure A-2. Sample recovery scheme.

and particulate matter have been collected in the sample container, tighten the lid on the sample container so that acetone will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether or not leakage occurred during transport. Label the container clearly to identify its contents.

5.2.3 Container No. 3 (Probe Rinse). Keep the probe assembly clean and free from contamination as described in Section 5.2.2 of this method during the 0.1 N nitric acid rinse described below. Rinse the probe nozzle and fitting, probe liner, and front half of the filter holder thoroughly with 100 mL of 0.1 N nitric acid and place the wash into a sample storage container. Note: The use of exactly 100 mL is necessary for the subsequent blank correction procedures. Perform the rinses as applicable and generally as described in Method 12, Section 5.2.2. Record the volume of the combined rinse. Mark the height of the fluid level on the outside of the storage container and use this mark to determine if leakage occurs during transport. Seal the container and clearly label the contents. Finally, rinse the nozzle, probe liner, and front half of the filter holder with water followed by acetone and discard these rinses.

5.2.4 Container No. 4 (Impingers 1 through 3, HNO_3/H_2O_2 Impingers and Moisture Knockout Impinger, when used, Contents and Rinses). Due to the potentially large quantity of liquid involved, the tester may place the impinger solutions from impingers 1 through 3 in more than one container. Measure the liquid in the first three impingers volumetrically to within 0.5 mL using a graduated cylinder. Record the volume of liquid present. This information is required to calculate the moisture content of the sampled flue gas. Clean each of the first three impingers, the filter support, the back half of the filter housing, and connecting glassware by thoroughly rinsing with 100 mL of 0.1 N nitric acid using the procedure as applicable and generally as described in Method 12, Section 5.2.4. Note: The use of exactly 100 mL of 0.1 N nitric acid rinse is necessary for the subsequent blank correction procedures. Combine the rinses and impinger solutions, measure and record the volume. Mark the height of the fluid level on the outside of the container to determine if leakage occurs during transport. Seal the container and clearly label the contents.

5.2.5 Container Nos. 5A, 5B, and 5C. 5A (0.1 N HNO_3), 5B ($KMnO_4/H_2SO_4$ absorbing solution), and 5C (8 N HCl rinse and dilution). (As described

impinger on its side and rotating it so that the HCl contacts all inside surfaces. Use a total of only 25 mL of 8 N HCl for rinsing both permanganate impingers combined. Rinse the first impinger, then pour the actual rinse used for the first impinger into the second impinger for its rinse. Finally, pour the 25 mL of 8 N HCl rinse carefully with stirring into Container No. 5C. Mark the height of the fluid level on the outside of the bottle to determine if leakage occurs during transport.

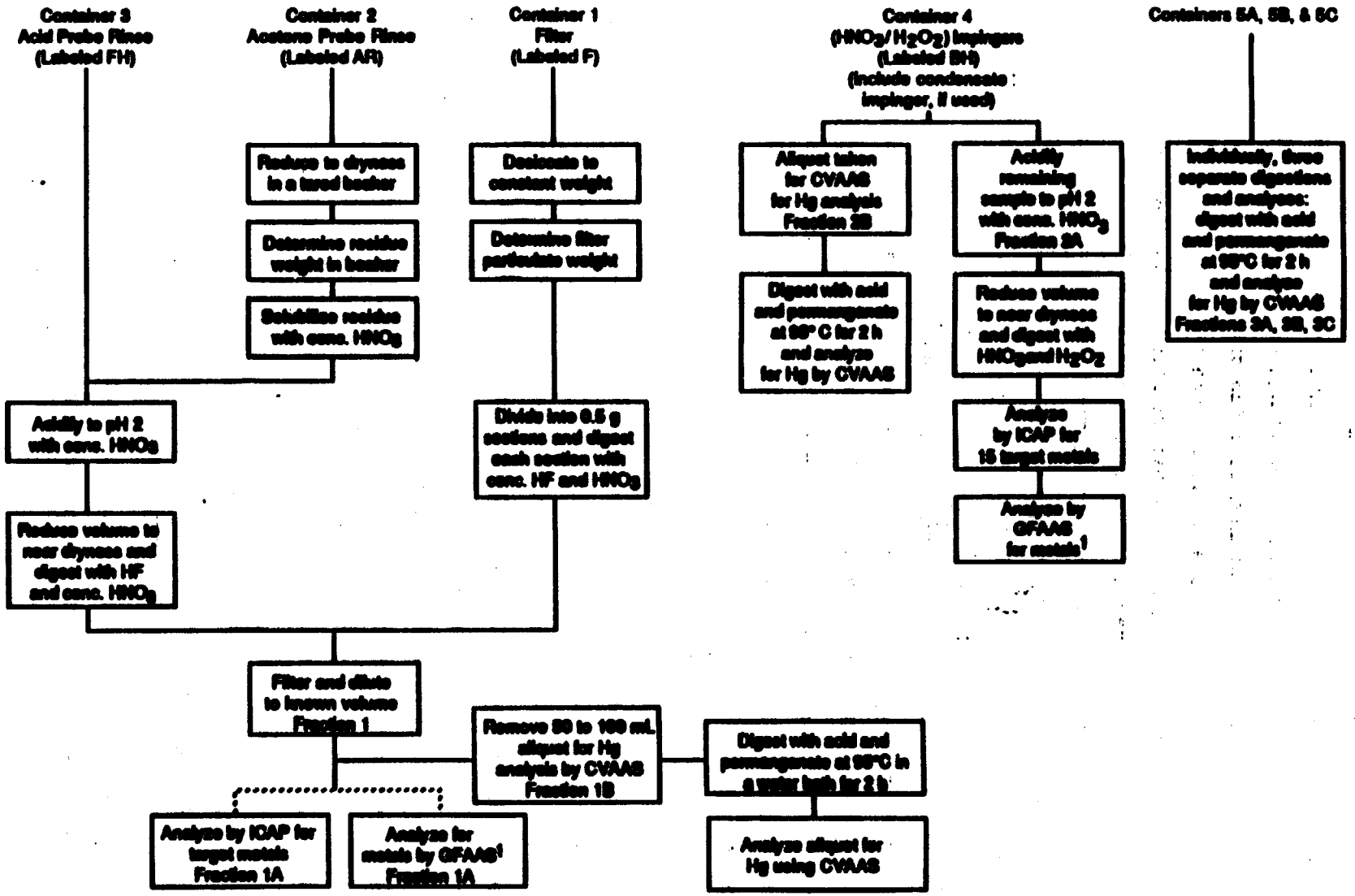
5.2.6 Container No. 6 (Silica Gel). Note the color of the indicating silica gel to determine whether it has been completely spent and make a notation of its condition. Transfer the silica gel from its impinger to its original container and seal. The tester may use a funnel to pour the silica gel and a rubber policeman to remove the silica gel from the impinger. The small amount of particles that may adhere to the impinger wall need not be removed. Do not use water or other liquids to transfer the silica gel since weight gained in the silica gel impinger is used for moisture calculations. Alternatively, if a balance is available in the field, record the weight of the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g.

5.2.7 Container No. 7 (Acetone Blank). If particulate emissions are to be determined, at least once during each field test, place a 100-mL portion of the acetone used in the sample recovery process into a labeled container for use in the front-half field reagent blank. Seal the container.

5.2.8 Container No. 8A (0.1 N Nitric Acid Blank). At least once during each field test, place 300 mL of the 0.1 N nitric acid solution used in the sample recovery process into a labeled container for use in the front-half and back-half field reagent blanks. Seal the container. Container No. 8B (water blank). At least once during each field test, place 100 mL of the water used in the sample recovery process into a labeled Container No. 8B. Seal the container.

5.2.9 Container No. 9 (5% Nitric Acid/10% Hydrogen Peroxide Blank). At least once during each field test, place 200 mL of the 5% nitric acid/10% hydrogen peroxide solution used as the nitric acid impinger reagent into a labeled container for use in the back-half field reagent blank. Seal the container.

5.2.10 Container No. 10 (Acidified Potassium Permanganate Blank). At least once during each field test, place 100 mL of the acidified potassium permanganate solution used as the impinger solution and in the sample recovery



[1] Analysis by AAS for metals found at less than 2 ug/mL in digestate solution, if desired. Or analyze for each metal by AAS, if desired.

Figure A-3. Sample preparation and analysis scheme.

solution to within 0.1 mL. Quantitatively remove a 50-mL aliquot and label as Fraction 1B. Label the remaining 250-mL portion as Fraction 1A. Fraction 1A is used for ICAP or AAS analysis. Fraction 1B is used for the determination of front-half mercury.

5.3.4 Container No. 4 (Impingers 1-3). Measure and record the total volume of this sample (Fraction 2) to within 0.5 mL. Remove a 75- to 100-mL aliquot for mercury analysis and label as Fraction 2B. Label the remaining portion of Container No. 4 as aliquot Fraction 2A. Aliquot Fraction 2A defines the volume of 2A prior to digestion. All of aliquot Fraction 2A is digested to produce concentrated Fraction 2A. Concentrated Fraction 2A defines the volume of 2A after digestion which is normally 150 mL. Only concentrated Fraction 2A is analyzed for metals (except that it is not analyzed for mercury). The Fraction 2B aliquot should be prepared and analyzed for mercury as described in Section 5.4.3. Aliquot Fraction 2A shall be pH 2 or lower. If necessary, use concentrated nitric acid by careful addition and stirring to lower aliquot Fraction 2A to pH 2. The sample should be rinsed into a beaker with water and the beaker should be covered with a ribbed watchglass. The sample volume should be reduced to approximately 20 mL by heating on a hot plate at a temperature just below boiling. Then follow either of the digestion procedures described in Sections 5.3.4.1 and 5.3.4.2, below.

5.3.4.1 Conventional Digestion Procedure. Add 30 mL of 50 percent nitric acid and heat for 30 minutes on a hot plate to just below boiling. Add 10 mL of 3 percent hydrogen peroxide and heat for 10 more minutes. Add 50 mL of hot water and heat the sample for an additional 20 minutes. Cool, filter the sample, and dilute to 150 mL (or the appropriate volume for the expected metals concentrations) with water. This dilution is concentrated Fraction 2A. Measure and record the volume of the Fraction 2A solution to within 0.1 mL.

5.3.4.2 Microwave Digestion Procedure. Add 10 mL of 50 percent nitric acid and heat for 6 minutes in intervals of 1 to 2 minutes at 600 Watts. Allow the sample to cool. Add 10 mL of 3 percent hydrogen peroxide and heat for 2 more minutes. Add 50 mL of hot water and heat for an additional 5 minutes. Cool, filter the sample, and dilute to 150 mL (or the appropriate volume for the expected metals concentrations) with water. This dilution is concentrated Fraction 2A. Measure and record the volume of the Fraction 2A solution to within 0.1 mL.

Note: All microwave heating times given are approximate and are

5.4.1 ICAP Analysis. Fraction 1A and Fraction 2A are analyzed by ICAP using EPA SW-846 Method 6010 or Method 200.7 (40 CFR 136, Appendix C). Calibrate the ICAP, and set up an analysis program as described in Method 6010 or Method 200.7. The quality control procedures described in Section 7.3.1 of this method shall be followed. Recommended wavelengths for use in the analysis are listed below.

Element	Wavelength (nm)
Aluminum	308.215
Antimony	206.833
Arsenic	193.696
Barium	455.403
Beryllium	313.042
Cadmium	226.502
Chromium	267.716
Copper	324.754
Iron	259.940
Lead	220.353
Manganese	257.610
Nickel	231.604
Phosphorous	214.914
Selenium	196.026
Silver	328.068
Thallium	190.864
Zinc	213.856

The wavelengths listed are recommended because of their sensitivity and overall acceptance. Other wavelengths may be substituted if they can provide the needed sensitivity and are treated with the same corrective techniques for spectral interference.

Initially, analyze all samples for the desired target metals (except mercury) plus iron and aluminum. If iron and aluminum are present in the sample, the sample may have to be diluted so that each of these elements is at a concentration of less than 50 ppm to reduce their spectral interferences on arsenic, cadmium, chromium, and lead.

Note: When analyzing samples in a hydrofluoric acid matrix, an alumina torch should be used; since all front-half samples will contain hydrofluoric acid, use an alumina torch.

5.4.2 AAS by Direct Aspiration and/or Graphite Furnace. If analysis of metals in Fraction 1A and Fraction 2A using graphite furnace or direct aspiration AAS is desired, Table A-2 should be used to determine which techniques and methods should be applied for each target metal. Table A-2

T. A-2 (Continued)

Metal	Technique	SW-846 Method No.	Wavelength (nm)	Interference	
				Cause	Minimization
Fe	Aspiration	7380	248.3	Contamination	Great care taken to avoid contamination
Pb	Aspiration	7420	283.3	217.0 nm alternate	Background correction required
Pb	Furnace	7421	283.3	Poor recoveries	Matrix modifier, add 10 uL of phosphorus acid to 1 mL of prepared sample in sampler cup
Mn	Aspiration	7460	279.5	403.1 nm alternate	Background correction required
Ni	Aspiration	7520	232.0	352.4 nm alternate	Background correction required
				Fe, Co, and Cr	Matrix matching or a nitrous-oxide/ acetylene flame
				Nonlinear response	Sample dilution or use 352.3 nm line
Se	Furnace	7740	196.0	Volatility	Spike samples and reference materials and add nickel nitrate to minimize volatilization
				Adsorption & scatter	Background correction is required and Zeeman background correction can be useful
Ag	Aspiration	7760	328.1	Adsorption & scatter	Background correction is required
				AgCl insoluble	Avoid hydrochloric acid unless silver is in solution as a chloride complex
				Viscosity	Sample and standards monitored for aspiration rate
Tl	Aspiration	7840	276.8		Background correction is required Hydrochloric acid should not be used
Tl	Furnace	7841	276.8	Hydrochloric acid or chloride	Background correction is required Verify that losses are not occurring for volatization by spiked samples or standard addition; Palladium is a suitable matrix modifier
Zn	Aspiration	7950	213.9	High Si, Cu, & P	Strontium removes Cu and phosphate
				Contamination	Great care taken to avoid contamination

6. Calibration

Maintain a laboratory log of all calibrations.

6.1 Sampling Train Calibration. Calibrate the sampling train components according to the indicated sections of Method 5: Probe Nozzle (Section 5.1); Pitot Tube (Section 5.2); Metering System (Section 5.3); Probe Heater (Section 5.4); Temperature Gauges (Section 5.5); Leak-Check of the Metering System (Section 5.6); and Barometer (Section 5.7).

6.2 Inductively Coupled Argon Plasma Spectrometer Calibration. Prepare standards as outlined in Section 4.4. Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures using the above standards. The instrument calibration should be checked once per hour. If the instrument does not reproduce the concentrations of the standard within 10 percent, the complete calibration procedures should be performed.

6.3 Atomic Absorption Spectrometer - Direct Aspiration, Graphite Furnace and Cold Vapor Mercury Analyses. Prepare the standards as outlined in Section 4.4. Calibrate the spectrometer using these prepared standards. Calibration procedures are also outlined in the EPA methods referred to in Table A-2 and in SW-846 Method 7470 or Standard Methods for Water and Wastewater, 15th Edition, Method 303F (for mercury). Each standard curve should be run in duplicate and the mean values used to calculate the calibration line. The instrument should be recalibrated approximately once every 10 to 12 samples.

7. Quality Control

7.1 Sampling. Field Reagent Blanks. When analyzed, the blank samples in Container Numbers 7 through 12 produced previously in Sections 5.2.7 through 5.2.12, respectively, shall be processed, digested, and analyzed as follows. Digest and process one of the filters from Container No. 12 per Section 5.3.1, 100 mL from Container No. 7 per Section 5.3.2, and 100 mL from Container No. 8A per Section 5.3.3. This produces Fraction Blank 1A and Fraction Blank 1B from Fraction Blank 1. [If desired, the other two filters may be digested separately according to Section 5.3.1, diluted separately to 300 mL each, and analyzed separately to produce a blank value for each of the two additional filters. If these analyses are performed, they will produce two additional values for each of Fraction Blank 1A and Fraction Blank 1B. The three Fraction Blank 1A values will be calculated as three values of M_{fab} in Equation 3 of Section 8.4.3, then the three values shall be totalled and divided by 3 to become the value M_{fab} to

(must be within 25% of calibration), and one duplicate analysis (must be within 10% of average or repeat all analyses).

7.3.2 Direct Aspiration and/or Graphite Furnace AAS Analysis for antimony, arsenic, barium, beryllium, cadmium, copper, chromium, lead, nickel, manganese, mercury, phosphorus, selenium, silver, thallium, and zinc. All samples should be analyzed in duplicate. Perform a matrix spike on at least one front-half sample and one back-half sample or one combined sample. If recoveries of less than 75 percent or greater than 125 percent are obtained for the matrix spike, analyze each sample by the method of additions. A quality control sample should be analyzed to check the accuracy of the calibration standards. The results must be within 10% or the calibration repeated.

7.3.3 Cold Vapor AAS Analysis for Mercury. All samples should be analyzed in duplicate. A quality control sample should be analyzed to check the accuracy of the calibration standards (within 15% or repeat calibration). Perform a matrix spike on one sample from the nitric impinger portion (must be within 25% or samples must be analyzed by the method of standard additions). Additional information on quality control can be obtained from EPA SW-846 Method 7470 or in Standard Methods for Water and Wastewater, 15th Edition, Method 303F.

8. Calculations

8.1 Dry Gas Volume. Using the data from this test, calculate $V_{m(std)}$, the dry gas sample volume at standard conditions as outlined in Section 6.3 of Method 5.

8.2 Volume of Water Vapor and Moisture Content. Using the data obtained from this test, calculate the volume of water vapor $V_{w(std)}$ and the moisture content B_{ws} of the stack gas. Use Equations 5-2 and 5-3 of Method 5.

8.3 Stack Gas Velocity. Using the data from this test and Equation 2-9 of Method 2, calculate the average stack gas velocity.

8.4 Metals (Except Mercury) in Source Sample.

8.4.1 Fraction 1A, Front Half, Metals (except Hg). Calculate separately the amount of each metal collected in Fraction 1 of the sampling train using the following equation:

$$M_{fh} = C_{s1} F_d V_{soln.1} \qquad \text{Eq. 1*}$$

*If Fractions 1A and 2A are combined, proportional aliquots must be used. Appropriate changes must be made in Equations 1-3 to reflect this approach.

Note: If the measured blank value for the front half (m_{fhb}) is in the range 0.0 to A ug [where A ug equals the value determined by multiplying 1.4 ug per square inch (1.4 ug/in.^{2}) times the actual area in square inches (in.^{2}) of the filter used in the emission sample], m_{fhb} may be used to correct the emission sample value (m_{fh}); if m_{fhb} exceeds A ug, the greater of the two following values (either I. or II.) may be used:

I. A ug, or

II. the lesser of (a) m_{fhb}, or (b) 5 percent of m_{fh}.

If the measured blank value for the back half (m_{bhb}) is in the range 0.0 to 1 ug, m_{bhb} may be used to correct the emission sample value (m_{bh}); if m_{bhb} exceeds 1 ug, the greater of the two following values may be used: 1 ug or 5 percent of m_{bh}.

8.5 Mercury in Source Sample.

8.5.1 Fraction 1B, Front Half, Hg. Calculate the amount of mercury collected in the front half, Fraction 1, of the sampling train using the following equation:

$$Hg_{fh} = \frac{Q_{fh}}{V_{f1B}} \times V_{soln.1} \qquad \text{Eq. 4}$$

where:

Hg_{fh} = total mass of mercury collected in the front half of the sampling train (Fraction 1), ug.

Q_{fh} = quantity of mercury in analyzed sample, ug.

$V_{soln.1}$ = total volume of digested sample solution (Fraction 1), mL.

V_{f1B} = volume of Fraction 1B analyzed, mL. See the following Note.

Note: V_{f1B} is the actual amount of Fraction 1B analyzed. For example, if 1 mL of Fraction 1B were diluted to 100 mL to bring it into the proper analytical range, and 1 mL of the 100-mL dilution were analyzed, V_{f1B} would be 0.01.

8.5.2 Fraction 2B and Fractions 3A, 3B, and 3C, Back Half, Hg. Calculate the amount of mercury collected in Fractions 2 using Equation 5 and in Fractions 3A, 3B, and 3C using Equation 6. Calculate the total amount of mercury collected in the back half of the sampling train using Equation 7.

where:

Hg_t = total mass of mercury collected in the sampling train, ug.
Hg_{frb} = blank correction value for mass of mercury detected in front-half field reagent blank, ug.
Hg_{bhb} = blank correction value for mass of mercury detected in back -half field reagent blanks, ug.

Note: If the total of the measured blank values ($Hg_{frb} + Hg_{bhb}$) is in the range of 0 to 6 ug, then the total may be used to correct the emission sample value ($Hg_{fh} + Hg_{bh}$); if it exceeds 6 ug, the greater of the following two values may be used: 6 ug or 5 percent of the emission sample value ($Hg_{fh} + Hg_{bh}$).

8.6 Metal Concentration of Stack Gas. Calculate each metal separately for the cadmium, total chromium, arsenic, nickel, manganese, beryllium, copper, lead, phosphorus, thallium, silver, barium, zinc, selenium, antimony, and mercury concentrations in the stack gas (dry basis, adjusted to standard conditions) as follows:

$$C_s = K_4 \, (M_t / V_{m(std)}) \qquad \text{Eq.9}$$

where:

C_s = concentration of each metal in the stack gas, mg/dscm.
K_4 = 10^{-3} mg/ug.
M_t = total mass of each metal collected in the sampling train, ug; (substitute Hg_t for M_t for the mercury calculation).
$V_{m(std)}$ = volume of gas sample as measured by the dry gas meter, corrected to dry standard conditions, dscm.

8.7 Isokinetic Variation and Acceptable Results. Same as Method 5, Sections 6.11 and 6.12, respectively.

9. Bibliography

9.1 Method 303F in Standard Methods for the Examination of Water Wastewater, 15th Edition, 1980. Available from the American Public Health Association, 1015 18th Street N.W., Washington, D.C. 20036.

9.2 EPA Methods 6010, 7000, 7041, 7060, 7131, 7421, 7470, 7740, and 7841. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. SW-846, Third Edition. September 1988. Office of Solid Waste and Emergency Response. U. S. Environmental Protection Agency, Washington, D.C. 20460.